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Knee Pain and Mobility Impairments: Meniscal and Articular Cartilage Lesions Revision 2018

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Orthopaedic Section of the American Physical Therapy Association

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Summary of Recommendations*†

EXAMINATION – OUTCOME MEASURES: ACTIVITY LIMITATIONS/ SELF-REPORTED MEASURES

2018 Recommendation

B For knee-specific outcomes, clinicians should use the International Knee Documentation Committee 2000 Subjective Knee Evaluation Form (IKDC 2000) or Knee injury and Osteoarthritis Outcome Score (KOOS) (or a culturally appropriate version for patients whose primary language is not English) and may use the Lysholm scale (with removal of swelling item, and using unweighted scores).

C Clinicians may use the Tegner scale or Marx activity rating scale to assess activity level before and after interventions intended to alleviate the physical impairments, activity limitations, and participation restrictions associated with meniscus or articular cartilage lesions; however, these have less evidence support about measurement properties. The Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) or the European Quality of Life-5 Dimensions (EQ-5D) are appropriate general health measures in this population. The Knee Quality of Life 26-item questionnaire (KQoL-26) may be used to assess knee-related quality of life.

EXAMINATION – PHYSICAL PERFORMANCE MEASURES

2018 Recommendation

C Clinicians may administer appropriate clinical or field tests, such as single-legged hop tests (eg, single hop for distance, crossover hop for distance, triple hop for distance, and 6-m timed hop), that can identify a patient's baseline status relative to pain, function, and disability; detect side-to-side asymmetries; assess global knee function; determine a patient's readiness to return to activities; and monitor changes in the patient's status throughout the course of treatment.

EXAMINATION – PHYSICAL IMPAIRMENT MEASURES

2018 Recommendation

B Clinicians should administer appropriate physical impairment assessments of body structure and function, at least at baseline and at discharge or 1 other follow-up point, for all patients with meniscus tears to support standardization for quality improvement in clinical care and research, including the modified stroke test for effusion assessment, assessment of knee active range of motion, maximum voluntary isometric or isokinetic quadriceps strength testing, forced hyperextension, maximum passive knee flexion, McMurray's maneuver, and palpation for joint-line tenderness.

D Clinicians may administer the appropriate physical impairment assessments of body structure and function, at least at baseline and at discharge or 1 other follow-up point, for all patients with articular cartilage lesions to support standardization for quality improvement in clinical care and research, including the modified stroke test for effusion assessment, assessment of knee active range of motion, maximum voluntary isometric or isokinetic quadriceps strength testing, and palpation for joint-line tenderness.

INTERVENTIONS – PROGRESSIVE KNEE MOTION

2018 Recommendation

B Clinicians may use early progressive active and passive knee motion with patients after knee meniscal and articular cartilage surgery.

INTERVENTIONS – PROGRESSIVE WEIGHT BEARING

2018 Recommendation

C Clinicians may consider early progressive weight bearing in patients with meniscal repairs.

B Clinicians should use a stepwise progression of weight bearing to reach full weight bearing by 6 to 8 weeks after matrix-supported autologous chondrocyte implantation (MACI) for articular cartilage lesions.

INTERVENTIONS – PROGRESSIVE RETURN TO ACTIVITY

2018 Recommendation

C Clinicians may utilize early progressive return to activity following knee meniscal repair surgery.

E Clinicians may need to delay return to activity depending on the type of articular cartilage surgery.

INTERVENTIONS – SUPERVISED REHABILITATION

2018 Recommendation

B Clinicians should use exercises as part of the in-clinic supervised rehabilitation program after arthroscopic meniscectomy and should provide and supervise the progression of a home-based exercise program, providing education to ensure independent performance.

INTERVENTIONS – THERAPEUTIC EXERCISES

2018 Recommendation

B Clinicians should provide supervised, progressive range-of-motion exercises, progressive strength training of the knee and hip muscles, and neuromuscular training to patients with knee meniscus tears and articular cartilage lesions and after meniscus or articular cartilage surgery.

INTERVENTIONS – NEUROMUSCULAR ELECTRICAL STIMULATION/BIOFEEDBACK

2018 Recommendation

B Clinicians should provide neuromuscular stimulation/re-education to patients following meniscus procedures to increase quadriceps strength, functional performance, and knee function.

*As per the original guidelines, these revised guidelines are primarily aimed at the diagnosis, evaluation, assessment, and treatment interventions of meniscal and articular cartilage lesions with respect to postsurgical care.

†These recommendations and clinical practice guidelines are based on the scientific literature published prior to December 2016.

List of Abbreviations

ACI: autologous chondrocyte implantation
ACL: anterior cruciate ligament
AE: athlete exposure
AGREE: Appraisal of Guidelines for Research and Evaluation
AMIC: autologous matrix-induced chondrogenesis
APM: arthroscopic partial meniscectomy
APTA: American Physical Therapy Association
CI: confidence interval
CPG: clinical practice guideline
EQ-5D: European Quality of Life-5 Dimensions
HCQ: Hughston Clinic Questionnaire
ICC: intraclass correlation coefficient
ICD: International Classification of Diseases
ICF: International Classification of Functioning, Disability and Health
ICRS: International Cartilage Repair Society
IKDC 2000: International Knee Documentation Committee 2000 Subjective Knee Evaluation Form
***JOSPT*:** *Journal of Orthopaedic & Sports Physical Therapy*
KOOS: Knee injury and Osteoarthritis Outcome Score
KQoL-26: Knee Quality of Life 26-item questionnaire
MACI: matrix-supported autologous chondrocyte implantation
MCID: minimal clinically important difference
MCMI: medial collagen meniscus implant
MRI: magnetic resonance imaging
OAT: osteochondral autograft transplantation
OCT: osteochondral transfer
OR: odds ratio
RCT: randomized controlled trial
SF-36: Medical Outcomes Study 36-Item Short-Form Health Survey
SF-6D: Medical Outcomes Study Short Form-6 Dimensions
SMD: standardized mean difference
VAS: visual analog scale
WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index
WOMET: Western Ontario Meniscal Evaluation Tool

Introduction

AIM OF THE GUIDELINES

The Orthopaedic Section of the American Physical Therapy Association (APTA) supports an ongoing initiative to create evidence-based clinical practice guidelines (CPGs) for orthopaedic physical therapy management of patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability and Health (ICF).[142]

The purposes of these clinical guidelines are to:

- Describe evidence-based physical therapy practice, including diagnosis, prognosis, intervention, and assessment of outcome for musculoskeletal disorders commonly managed by orthopaedic physical therapists
- Classify and define common musculoskeletal conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
- Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common musculoskeletal conditions
- Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure as well as in activity and participation of the individual
- Provide a description to policy makers, using internationally accepted terminology, of the practice of orthopaedic physical therapists
- Provide information for payers and claims reviewers regarding the practice of orthopaedic physical therapy for common musculoskeletal conditions
- Create a reference publication for orthopaedic physical therapy clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic physical therapy

STATEMENT OF INTENT

These guidelines are not intended to be construed or to serve as a standard of medical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered

Introduction *(continued)*

guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made based on clinician experience and expertise in light of the clinical presentation of the patient, the available evidence, available diagnostic and treatment options, and the patient's values, expectations, and preferences. However, we suggest that significant departures from accepted guidelines should be documented in the patient's medical records at the time the relevant clinical decision is made.

SCOPE

The aims of the revision were to provide a concise summary of the evidence since publication of the original guideline in 2010 and to develop new recommendations or revise previously published recommendations to support evidence-based practice. The original guidelines were primarily aimed at the diagnosis, evaluation, assessment, and treatment interventions of meniscus and articular cartilage lesions with respect to postsurgical care, and this revision builds on the original guidelines. The state of the literature in the nonoperative management of meniscus and articular cartilage lesions is rapidly evolving and will be explored and presented in the next iteration of this CPG.

Methods

Content experts with relevant physical therapy, medical, and surgical expertise were appointed by the Orthopaedic Section, APTA, Inc to conduct a review of the literature and to develop an updated Knee Pain and Mobility Impairments Meniscal and Articular Cartilage Lesions CPG as indicated by the current state of the evidence in the field. Four authors of this guideline revision completed the Appraisal of Guidelines for Research and Evaluation (AGREE) II tool to assess the quality and reporting of the CPG published in 2010, and to identify areas for improvement. The authors of this guideline revision worked with the CPG Editors and medical librarians for methodological guidance. The research librarians were chosen for their expertise in systematic review rehabilitation literature search, and to perform systematic searches for concepts associated with meniscus and articular cartilage injuries of the knee in articles published from 2008 related to classification, examination, and intervention strategies consistent with previous guideline development methods related to ICF classification.[91] Briefly, the following databases were searched from 2008 to December 31, 2016: MEDLINE (PubMed, 2008 to date), Scopus (Elsevier BV, 2008 to date), CINAHL (EBSCO, 2008 to date), SPORTDiscus (EBSCO, 2008 to date), and Cochrane Library (Wiley, 2008 to date). (See **APPENDIX A** for full search strategies and **APPENDIX B** for search dates and results, available at www.orthopt.org.)

The authors declared relationships and developed a conflict management plan that included submitting a Conflict of Interest form to the Orthopaedic Section, APTA, Inc. Articles that were authored by a reviewer were assigned to an alternate reviewer. Funding was provided to the CPG development team for travel and expenses for CPG development training by the Orthopaedic Section, APTA, Inc. The CPG development team maintained editorial independence.

Articles contributing to recommendations were reviewed based on specified inclusion and exclusion criteria with the goal of identifying evidence relevant to physical therapist clinical decision making for adult persons with knee pain and mobility impairments/knee meniscal/articular cartilage lesions. The title and abstract of each article were reviewed independently by 2 members of the CPG development team for inclusion. (See **APPENDIX C** for inclusion and exclusion criteria, available at www.orthopt.org.) Full-text review was then similarly conducted to obtain the final set of articles for contribution to recommendations. The team leader (D.S.L.) provided the final decision for discrepancies that were not resolved by the review team. (See **APPENDIX D** for a flow chart of articles and **APPENDIX E** for articles included in recommendations by topic, available at www.orthopt.org.) For selected relevant topics that were not appropriate for the development of recommendations, such as incidence and imaging, articles were not subject to the systematic review process and were not included in the flow chart. Evidence tables for this CPG are available on the Clinical Practice Guidelines page of the Orthopaedic Section of the APTA website: www.orthopt.org.

This guideline was issued in 2018 based on the published literature up to December 2016, and will be considered for review in 2022, or sooner if new evidence becomes available that may change the recommendations. Any updates to the

Methods *(continued)*

guideline in the interim period will be noted on the Orthopaedic Section of the APTA website: www.orthopt.org.

LEVELS OF EVIDENCE

Individual clinical research articles were graded according to criteria adapted from the Centre for Evidence-Based Medicine, Oxford, United Kingdom for diagnostic, prospective, and therapeutic studies.[114] In 3 teams of 2, each reviewer independently assigned a level of evidence and evaluated the quality of each article using a critical appraisal tool. (See **APPENDICES F** and **G** for the Levels of Evidence table and details on procedures used for assigning levels of evidence, available at www.orthopt.org.) The evidence update was organized from highest level of evidence to lowest level. An abbreviated version of the grading system is provided below.

I	Evidence obtained from systematic reviews, high-quality diagnostic studies, prospective studies, or randomized controlled trials
II	Evidence obtained from systematic reviews, lesser-quality diagnostic studies, prospective studies, or randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, less than 80% follow-up)
III	Case-control studies or retrospective studies
IV	Case series
V	Expert opinion

GRADES OF EVIDENCE

The strength of the evidence supporting the recommendations was graded according to the previously established methods for the original guideline and those provided below. Each team developed recommendations based on the strength of evidence, including how directly the studies addressed the question on knee pain and mobility impairments/meniscus and articular cartilage lesion population. In developing their recommendations, the authors considered the strengths and limitations of the body of evidence and the health benefits, side effects, and risks of tests and interventions.

GRADES OF RECOMMENDATION BASED ON		STRENGTH OF EVIDENCE
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation
C	Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies
E	Theoretical/ foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/ principles, or from basic science/bench research support this conclusion
F	Expert opinion	Best practice based on the clinical experience of the guidelines development team

DESCRIPTION OF GUIDELINE VALIDATION

Identified reviewers who are experts in knee meniscus and articular cartilage injury management and rehabilitation reviewed this CPG content and methods for integrity, accuracy, and that it fully represents the condition. All comments, suggestions, or feedback from the expert reviewers were delivered to the authors and editors to consider and make appropriate revisions. These guidelines were also posted for public comment and review on the orthopt.org website and a notification of this posting was sent to the members of the Orthopaedic Section, APTA, Inc. All comments, suggestions, and feedback gathered from public commentary were sent to the authors and editors to consider and make appropriate revisions in the guideline. In addition, a panel of consumer/patient representatives and external stakeholders, such as claims reviewers, medical coding experts, academic educators, clinical educators, physician specialists, and researchers, also reviewed the guideline and provided feedback and recommendations that were given to the authors and editors for further consideration and revisions. Last, a panel of consumer/patient representatives and external stakeholders and a panel of experts in physical therapy practice guideline methodology annually review the Orthopaedic Section, APTA's ICF-based Clinical Practice Guideline policies and provide feedback and comments to the Clinical Practice Guidelines Coordinator and Editors to improve the Association's guideline development and implementation processes.

DISSEMINATION AND IMPLEMENTATION TOOLS

In addition to publishing these guidelines in the *Journal of Orthopaedic & Sports Physical Therapy* (*JOSPT*), these guidelines will be posted on CPG areas of both the *JOSPT* and the Orthopaedic Section, APTA websites, which are free-access website areas, and submitted to be available free access on the Agency for Healthcare Research and Quality's website (www.guideline.gov). The implementation tools planned to be available for patients, clinicians, educators, payers, policy

Methods *(continued)*

makers, and researchers, and the associated implementation strategies, are listed in the **TABLE**.

CLASSIFICATION

The International Classification of Diseases-10 (ICD-10) codes and conditions associated with knee pain and mobility disorders are **S83.2 Tear of meniscus, current**; **M23.2 Derangement of meniscus due to old tear or injury**; and **S83.3 Tear of articular cartilage of knee, current**.

The corresponding ICD-9 Clinical Modification (CM) codes and conditions, which are used in the United States, associated with knee pain and mobility disorders are **836.0 Tear of medial cartilage or meniscus of knee, current**; **836.1 Tear of lateral cartilage or meniscus of knee, current**; **717.0 Old bucket handle tear of medial meniscus**; **717.1 Derangement of anterior horn of medial meniscus**; **717.2 Derangement of posterior horn of medial meniscus**; **717.3 Other and unspecified derangement of medial meniscus**; **717.40 Derangement of lateral meniscus unspecified**; **717.41 Bucket handle tear of lateral meniscus**; **717.42 Derangement of anterior horn of lateral meniscus**; **717.43 Derangement of posterior horn of lateral meniscus**; **717.49 Other derangement of lateral meniscus**; and **717.89 Other internal derangement of knee**.

The primary ICF body functions codes associated with the above-noted ICD-10 conditions are **b28016 Pain in joints**; **b7100 Mobility of a single joint**; and **b770 Gait pattern functions**.

The primary ICF body structures codes associated with knee pain and mobility disorders are **s75000 Bones of thigh, s75010 Bones of lower leg**; **s75011 Knee joint**; and **s75018 Structure of lower leg, specified as fibrocartilage or hyaline cartilage of the knee**.

The primary ICF activities and participation codes associated with knee pain and mobility disorders are **d2302 Completing the daily routine** and **d4558 Moving around, specified as quick direction changes while walking or running**.

A comprehensive list of codes was published in the previous guideline.[91]

ORGANIZATION OF THE GUIDELINE

For each topic, the summary recommendation and grade of evidence from the 2010 guideline are presented, followed by a synthesis of the recent literature with the corresponding evidence levels. Each topic concludes with the 2018 summary recommendation and its updated grade of evidence.

TABLE Planned Strategies and Tools to Support the Dissemination and Implementation of This Clinical Practice Guideline

Tool	Strategy
"Perspectives for Patients"	Patient-oriented guideline summary available on www.jospt.org and www.orthopt.org
Mobile app of guideline-based exercises for patients/clients and health care practitioners	Marketing and distribution of app using www.orthopt.org and www.jospt.org
Clinician's quick-reference guide	Summary of guideline recommendations available on www.orthopt.org
Read-for-credit continuing education units	Continuing education units available for physical therapists and athletic trainers through *JOSPT*
Educational webinars for health care practitioners	Guideline-based instruction available for practitioners on www.orthopt.org
Mobile and web-based app of guideline for training of health care practitioners	Marketing and distribution of app using www.orthopt.org and www.jospt.org
Physical Therapy National Outcomes Data Registry	Support the ongoing usage of data registry for common musculoskeletal conditions of the head and neck region
Logical Observation Identifiers Names and Codes mapping	Publication of minimal data sets and their corresponding Logical Observation Identifiers Names and Codes for the head and neck region on www.orthopt.org
Non-English versions of the guidelines and guideline implementation tools	Development and distribution of translated guidelines and tools to *JOSPT*'s international partners and global audience via www.jospt.org

CLINICAL GUIDELINES

Impairment/Function-Based Diagnosis

INCIDENCE

2010 Summary

Meniscus

Injuries to the menisci are the second most common injury to the knee, with a prevalence of 12% to 14% and an incidence of 61 cases per 100 000 persons.[96,128] A high incidence of meniscal tears occur with injury to the anterior cruciate ligament (ACL), ranging from 22% to 86%.[105] In the United States, 10% to 20% of all orthopaedic surgeries consist of surgery to the meniscus on an estimated 850 000 patients each year.[117]

Articular Cartilage

Based on studies of knee arthroscopies, the prevalence of articular cartilage pathologies is reported to be between 60% and 70%.[8,69] The incidence of isolated articular cartilage lesions (30%) is lower than that of nonisolated cartilage lesions.[139] Thirty-two percent to 58% of all articular cartilage lesions are the result of a traumatic, noncontact mechanism of injury.[74,139] Sixty-four percent of all chondral lesions were less than 1 cm^2.[139] Thirty-three percent to 60% of articular cartilage lesions are greater than grade 3 lesions on the International Cartilage Repair Society (ICRS) grading system.[36,130] The ICRS cartilage injury classification consists of 5 grading levels, from grade 0 (normal cartilage without notable defects) to grade 4 (severely abnormal, full-thickness osteochondral injury).[21] The most frequent localizations of cartilage lesions were to the medial femoral condyle and the patellar articular surface.[139] Medial meniscal tears (37%) and ACL ruptures (36%) were the most common injuries concomitant with articular cartilage injuries.

Evidence Update

Meniscus

Tear patterns of the knee meniscus can be classified as either traumatic tears or degenerative tears.[46] Younger active participants are more likely to sustain traumatic meniscus injuries, such as longitudinal or radial tears. Older individuals are more likely to have degenerative tears, such as horizontal cleavages, flap or complex tears, or meniscal maceration or destruction.[46]

II In active-duty US military service personnel, Jones et al[75] reported an unadjusted incidence rate of 8.27 per 1000 person-years (95% CI: 8.22, 8.32) for acute meniscal injury. For men, the adjusted rate per 1000 person-years was 7.08 and for women was 6.02. Oldest service personnel (older than 40 years of age) had more than 4 times (4.25) the adjusted rate of meniscus tears compared to youngest (less than 20 years of age) service personnel.

III Yeh et al[146] identified 129 isolated meniscus tears over a 21-season span in 1797 professional basketball players. One hundred eleven injuries (86.7%) were the result of a single incident. Lateral meniscus tears were involved in 59.2% and medial meniscus tears were involved in 40.8% of cases. Isolated tears accounted for 87.8% of cases, whereas 12.2% of cases were concomitant with a ligamentous injury. They reported an overall clinical incidence of 8.2 meniscus tears per 100 athletes. Lateral meniscus tears were more likely to occur in younger athletes (younger than or equal to 30 years of age), whereas medial meniscus tears were more prevalent in athletes older than 30 years of age.

IV In an injury surveillance study of high school athletes, the meniscus was involved in 23.0% of all knee injuries in all reported sports, corresponding to 0.51 injuries per 10 000 athlete exposures (AEs).[129] In sex-comparable sports, boys had 0.22 injuries per 10 000 AEs and girls had 0.42 injuries per 10 000 AEs, resulting in girls having a higher rate of meniscus injuries compared to boys (rate ratio = 1.88; 95% CI: 1.48, 2.40).

IV In a claims analysis study, Abrams et al[1] reported that from 2005 to 2011, 387 833 meniscectomies and 23 640 meniscus repairs were performed in the United States. The majority of meniscectomies performed were in the 45-to-54-year-old and 55-to-64-year-old age groups (32.9% and 32.2%, respectively, in 2011), whereas the majority of meniscal repairs were performed in the under-25-year-old and 25-to-34-year-old age groups (55.2% and 19.5%, respectively, in 2011). The authors reported only a small increase in the number of yearly meniscectomies from 2005 to 2011 (4.7%), but there was a larger increase (11.4%) in the number of yearly meniscus repairs. The overall incidence of meniscectomies went from 0.21% per year to 0.24% per year, whereas the incidence of meniscal repairs went from 0.01% per year to 0.02% per year.

IV Similarly, in Denmark from 2000 to 2011, the number of yearly meniscus procedures doubled from 8750 to 17 368.[134] The largest increases in incidence rate in the same time period were seen in patients older than 55 years (3-fold increase) and in patients between 35 and 55 years of age (2-fold increase).

Articular Cartilage

II A systematic review of 11 studies (931 participants) looking at the prevalence of chondral lesions in athletes' knees identified by arthroscopy or magnetic resonance imaging (MRI) found that the overall prevalence of full-thickness focal chondral lesions was 36% (range, 2.4%-75%).[51] Thirty-five percent of lesions were located in the femoral condyles, 37% in the patella and trochlea, and 25% in the tibial plateaus. The prevalence of full-thickness focal chondral lesions in asymptomatic individuals was 14%, but was substantially higher in basketball players and endurance runners (59%; range, 18%-63%).

II Brophy et al[22] examined 725 participants with revision ACL reconstructions to determine the presence of chondral lesions and their relationship with prior meniscus surgery. After adjusting for patient age, knees with prior partial meniscectomy were more likely to have cartilage deterioration compared to knees with prior meniscus repair or no previous history of meniscus surgery.

IV Nepple et al[103] identified 432 articular cartilage abnormalities in 704 knee MRI scans from 594 participants from the National Football League Scouting Combine. Full-thickness lesions were present in 17% of knees, with the lateral compartment being the most common site. Previous surgery to the knee was significantly associated with full-thickness articular cartilage lesions.

IV In a retrospective review, Ralles et al[115] reported that a delay in ACL reconstruction (greater than 12 months from the index injury) was associated with an increased incidence of medial meniscus lesions and cartilage lesions. Additionally, less active patients (based on Marx activity rating scale less than 7) were more likely to have cartilage lesions and medial meniscus tears compared to those who were more active.

Meniscus and Articular Cartilage

III Wyatt et al[144] investigated the prevalence of meniscus and cartilage lesions in a sample of 261 patients who had primary and subsequent revision ACL reconstruction. The prevalence of cartilage injuries was twice as common among those undergoing revision ACL reconstruction (31.8%) compared to those undergoing primary ACL reconstruction (14.9%). There was a higher prevalence of meniscus tears at primary ACL reconstruction (54.8%) compared to revision ACL reconstruction (43.7%). There was a higher prevalence of lateral meniscus tears at primary ACL reconstruction (37.2%) compared to revision ACL reconstruction (18.4%), but no difference in prevalence of medial meniscus tears between primary (32.6%) and revision reconstruction (32.6%).

IV Kuikka et al[87] reported on population-based incidence in young military men. They reported an incidence of 3.1 per 1000 person-years (95% CI: 2.7, 3.4) for old meniscus tears, 2.2 per 1000 person-years (95% CI: 1.9, 2.5) for new meniscus tears, and 0.2 per 1000 person-years (95% CI: 0.1, 0.3) for fresh chondral lesions. Twenty-seven percent of individuals were hospitalized for old meniscus tears, 19.9% for new meniscus tears, and 1.7% for chondral lesions. They reported that one third of service class changes were the result of meniscal tears and new chondral lesions.

2018 Summary

Meniscus lesions account for almost one quarter of all knee injuries. In high school athletes, girls may have higher incidence of meniscus tears than boys. Older individuals have a higher rate of meniscus tears compared to younger individuals. Lateral meniscus tears are more likely to occur in younger athletes, and medial meniscus tears are more likely to occur in older people. A high prevalence of meniscus tears are present in individuals undergoing primary and revision ACL reconstruction. Individuals older than 45 years of age are more likely to have meniscectomy, whereas individuals younger than 35 years of age are more likely to have meniscus repair. The incidence rate of meniscus procedures (partial meniscectomies and meniscus repairs) has substantially increased over the past decade.

The prevalence of articular cartilage lesions in athletes' knees ranges from 17% to 59%, some of those athletes being asymptomatic. The incidence rate of articular cartilage lesions is high after partial meniscectomy or second ACL injury.

PATHOANATOMICAL FEATURES

2010 Summary

Meniscus

The medial and lateral menisci cover the superior aspect of the tibia.[20] Each meniscus is composed of fibrocartilage and is wedge shaped. The lateral meniscus is more circular, whereas the medial meniscus is more crescent shaped. The lateral meniscus is more mobile than the medial meniscus. The menisci function to distribute stress across the knee during weight bearing, provide shock absorption, serve as secondary joint stabilizers, provide articular cartilage nutrition and lubrication, facilitate joint gliding, prevent hyperextension, and protect the

joint margins.[20] Individuals who sustain a meniscal tear report a similar history as an individual with an ACL tear, such as feeling a "pop" while suddenly changing direction with or without contact.[20] The rate of medial meniscal tears increases over time, whereas lateral meniscal tears do not.[76,105,130] Prolonged delays in ACL reconstruction are related to increased occurrence of meniscus injuries.[105]

Articular Cartilage

The articular cartilage that covers the gliding surfaces of the knee joint is hyaline in nature.[16,88] Hyaline cartilage decreases the friction between gliding surfaces, withstands compression by acting as a shock absorber, and resists wear during normal situations.[16,24] Injuries to the articular cartilage can be the result of acute trauma or repetitive minor trauma.[16,74,139] Some individuals who sustain articular surface injury do not seek treatment. Many lesions are nonprogressive and remain asymptomatic, while some experts believe that even small asymptomatic lesions may increase in size and eventually become painful if left untreated.[55] Four methods of operative care that are most widely used are arthroscopic lavage and debridement, microfracture, autologous chondrocyte implantation (ACI), and osteochondral autograft transplantation (OAT).[88]

Evidence Update

None.

2018 Summary

Partial meniscectomy is the primary surgical procedure used to treat meniscus tears. Microfracture procedures for articular cartilage lesions are largely used for young patients, are associated with good outcomes, and have been combined with an extrinsic matrix known as autologous matrix-induced chrondrogenesis (AMIC).

CLINICAL COURSE

2010 Recommendation

C Knee pain and mobility impairments associated with meniscal and articular cartilage tears can be the result of a contact or noncontact incident, which can result in damage to one or more structures. Clinicians should assess for impairments in range of motion, motor control, strength, and endurance of the limb associated with the identified meniscal or articular cartilage pathology or following meniscal or chondral surgery.

Evidence Update

Meniscus

I A systematic review of arthroscopy surgery for degenerative meniscus tears reported minimal short-term improvement favoring arthroscopy surgery compared to other treatments for pain that was then absent at 1 to 2 years.[135] Furthermore, harms, such as symptomatic deep venous thrombosis, pulmonary embolism, infection, and death, are associated with knee arthroscopy.[135]

I In a randomized controlled trial (RCT), Frobell et al[52] reported that the number of meniscus surgeries over a 5-year period after ACL injury was similar in those who had early ACL reconstruction (n = 29) and those who had initial rehabilitation with the option of later reconstruction (n = 32). However, the frequency of repeated meniscus surgery was lower in those who had early ACL reconstruction compared to those who had initial rehabilitation with the option of later reconstruction.

I Katz et al[78] randomized 351 patients with a meniscus tear and mild to moderate knee osteoarthritis into either APM and rehabilitation or rehabilitation only. Patients were followed up at 6 and 12 months, and results were similar for the 2 groups. In the intention-to-treat analysis (adjusted for study site), at 6 months, the mean Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) physical function score improved by 20.9 points for the surgical group and 18.5 points for the rehabilitation group. At 12 months, the mean scores improved by 23.5 and 22.8 points for the surgical and rehabilitation groups, respectively. Similar improvements in both groups were reported in Knee injury and Osteoarthritis Outcome Score (KOOS) pain subscale scores at both time points. At 6 months, 30% of the patients assigned to the rehabilitation group crossed over to the surgery group, whereas 5% of patients assigned to the surgery group chose not to undergo surgery.

II A systematic review of 367 participants from 7 studies (1 RCT and 6 retrospective observational trials) evaluated outcomes comparing meniscal repair to meniscectomy.[145] Patients post meniscus repair reported similar long-term International Knee Documentation Committee 2000 Subjective Knee Evaluation Form (IKDC 2000) scores, higher Lysholm scores (mean difference, 5.24), and less change in Tegner scores (median difference, −0.81) compared to patients post meniscectomy. Patients post meniscus repair had better self-reported knee function and less activity loss compared to those post meniscectomy. However, the length of follow-up after surgery and type of study design may have influenced the outcomes.

II Hall et al[61] performed a systematic review on knee extensor muscle strength in patients older than 29 years undergoing APM, reporting on 11 studies involving 596 individuals. Before APM surgery, patients with

meniscus tear had lower knee extensor strength compared to healthy controls or their noninjured limb, with a standardized mean difference (SMD) of −0.58 (95% CI: −1.13, −0.04,). After surgery, the lower knee extensor muscle strength persisted for up to 4 years (1 week after surgery: SMD, −2.42; 95% CI: −3.36, −1.48; 3-4 weeks after surgery: SMD, −0.47; 95% CI: −1.06, 0.12; 12 weeks after surgery: SMD, −0.47; 95% CI: −0.91, 0.02; 6 months after surgery: SMD, −0.56; 95% CI: −1.05, −0.07; 2 years after surgery: SMD, −0.01; 95% CI: −0.36, 0.35; and 4 years after surgery: SMD, −0.56; 95% CI: −1.20, 0.08). They reported that the involved limb was 11% to 12% weaker than controls before APM and up to 4 years after APM (except for the 2-year time point after APM).

II A systematic review of 4 studies (prospective and cross-sectional) assessing quadriceps strength after APM reported large quadriceps strength deficits less than 1 month after surgery (Cohen's d = −1.01 to −1.62), small to large deficits 1 to 3 months after surgery (d = −0.40 to −8.04), small to large deficits 3 to 6 months after surgery (d = −0.40 to −5.11), and small deficits (d = −0.30 to −0.37) more than 6 months after surgery.[97]

II In patients with degenerative meniscus lesions, Østerås et al[109] randomized 17 patients to either specialized exercise therapy or APM. The exercise therapy group had similar to better adjusted differences in change from baseline to 3 months' follow-up compared to the APM group for visual analog scale (VAS) pain scores (exercise therapy, −1.1; APM, −1.1), total KOOS scores (exercise therapy, −10.7; APM, −8.9), Hospital Anxiety and Depression Scale scores (exercise therapy, −1.7; APM, −0.7), and quadriceps muscle strength with maximal external load using 5 repetitions (exercise therapy, 10.5; APM, 4.1).

II Al-Dadah et al[3] investigated proprioception and self-reported knee function preoperatively (baseline) and 3 months later (follow-up) in patients undergoing knee arthroscopy. At baseline, the group scheduled for APM (n = 50) had impaired proprioception compared to healthy controls and the contralateral uninjured knee. At follow-up, despite improvements in perceived knee function according to Lysholm, Cincinnati, and IKDC 2000 scores compared to preoperative scores, the APM leg continued to demonstrate impaired proprioception compared to the normal contralateral knee and to healthy controls.

II Busija et al[26] assessed the change in Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) scores in patients undergoing 4 types of orthopaedic surgeries (APM, ACL reconstruction, total hip arthroplasty, and total knee arthroplasty). In 63 patients (85%) who underwent APM and completed 3-month follow-up assessment, a large effect size (1.0) was observed for improvement in body pain and a moderate effect size (0.70) for the physical component summary of the SF-36.

II Fabricant et al[48] studied factors related to patient recovery 12 months following APM. There were 141 patients included at baseline (tested 2-6 weeks prior to surgery) and 126 (89%) completed the study. Pain and knee function were rated by the surgeon. Variables assessed to predict recovery rate included osteoarthritis severity (modified Outerbridge score), meniscal excision depth, involvement of both menisci, extent of tear, sex, age, body mass index, and time (preoperative and 1, 3, 8, 16, 24, and 48 weeks post surgery). Of the variables assessed, female sex and greater osteoarthritis severity were associated with slower rate of short- to intermediate-term pain recovery, functional recovery, and overall knee status.

II In this 10-year study, Zaffagnini et al[147] compared clinical and structural outcomes in patients receiving a medial collagen meniscus implant (MCMI) compared to patients undergoing APM. Thirty-three of the 36 patients returned for reassessment (92%), and results showed that on average, patients receiving MCMI (n = 17) compared to the APM group (n = 16) had similar pain (VAS, 1.2 versus 1.8), higher physical activity levels (Tegner activity scale, 7.5 versus 5.0), and less joint space narrowing (radiographs, 0.48 mm versus 2.13 mm).

II Kijowski et al[81] evaluated whether preoperative MRI features were associated with clinical outcomes 1 year later. In 100 patients undergoing APM, clinical outcomes were assessed using the IKDC 2000 and structural integrity was assessed using the Boston Leads Osteoarthritis Knee scoring system. Poorer clinical outcome after surgery was associated with greater severity of cartilage loss and bone edema, specific to the compartment of the meniscal tear. Meniscal root tears were associated with an increased risk for limited improvement in middle-aged and older patients following APM.

II Thorlund et al[132] assessed knee muscle strength, including maximal isometric knee extension and flexion, 1-leg hop for distance, and maximum number of 1-leg hops in 30 seconds, and found no difference in change in knee muscle strength from 2 years post APM to 4 years post APM in patients who had undergone APM compared to healthy controls. The KOOS quality of life subscale was lower in patients 4 years after APM (mean ± SD, 78.7 ± 3.6) compared to healthy controls (90.0 ± 2.7; Cohen d = 3.6), with no differences in the other 4 KOOS subscale scores between patients and controls.

II A series of publications from a 2-year longitudinal cohort study assessed 82 patients 3 months post APM of the medial meniscus (baseline), with 66 (80%) who returned 2 years later for reassessment (follow-up).[62-64,133] Thirty-eight healthy controls were assessed at baseline and 23 (61%) returned for reassessment 2 years later. At baseline, the operated leg had a lower maximum loading rate during early stance phase of walking compared to healthy controls. The peak vertical force during stance increased (relative to baseline) in the operated leg compared to healthy controls over time.[63] Knee muscle weakness in the operated leg reported at 3 months following surgery compared to controls had recovered 2 years later, such that no differences were observed at follow-up between groups.[64] Higher peak knee adduction moment and knee adduction moment impulse (indicators of knee joint loading) during walking were found in patients 3 months following surgery compared to healthy controls. Knee muscle weakness 3 months following APM was not associated with change in the knee adduction moment over the subsequent 2 years.[62] At baseline, in a subgroup of these patients (n = 66), greater varus, valgus, and total knee joint angular laxity were found compared to healthy controls. No differences were observed in change in stiffness over the 2-year period between the operated legs and controls.[133]

III Stein et al[126] investigated clinical and radiographic outcomes in patients with an isolated traumatic medial meniscal tear who had undergone a meniscal repair (n = 42) or partial meniscectomy (n = 39). At long-term follow-up (5-8 years after surgery), 56% of the cohort (meniscal repair, 62%; partial meniscectomy, 51%) returned for follow-up, and osteoarthritis progression was greater in the meniscectomy group (40%) compared to the meniscal repair group (20%). There was no difference between groups in knee function using the Lysholm score (meniscal repair, 91.5; partial meniscectomy, 88.4). Following rehabilitation, 95% of the repair group returned to preinjury activity levels based upon Tegner activity scale measures, compared to 50% in the meniscectomy group.

III Scanzello et al[122] investigated whether synovitis in patients undergoing APM (n = 33) predicted postoperative symptoms. Synovitis and hyperplasia were assessed via surgical biopsies. In patients with inflammation, Lysholm scores and the physical component summary of the Medical Outcomes Study 12-Item Short-Form Health Survey were worse preoperatively. However, there was no association between synovial inflammation and self-reported symptoms at 16 weeks, 1 year, and 2 years postoperatively.

III Kim et al[82] evaluated return to sport after surgery in 56 athletes undergoing APM. Athletes younger than 30 years returned to sport on average 54 days following surgery, while those older than 30 years returned to sports later, on average 89 days following surgery. Patients with medial meniscus tears had a longer return-to-sport time (79 days) than those with lateral meniscus tears (61 days). Elite and competitive athletes had shorter return-to-sport time (53-54 days) than recreational athletes (88 days). Therefore, age, level of physical activity, and which meniscus is torn may influence time to return to sport.

Articular Cartilage

I Goyal et al[58] performed a systematic review of level I and II studies on microfracture surgery, reporting on 6 studies with long-term follow-up and 9 with short-term follow-up. Patients with small articular cartilage lesions (less than 5 cm^2) treated with microfracture surgery who returned to low-load activities postoperatively had good short-term outcomes. Patients with small lesions who returned to higher-demand activities had an increased progressive failure rate. For large lesions (greater than 4 cm^2), self-reported outcomes improved up to 5 years after microfracture surgery. The authors of the review reported that younger patients, regardless of lesion size, had better outcomes than older patients.

I Goyal et al[57] performed a systematic review of level I and II studies on osteochondral transfer (OCT) procedures, compared to other articular cartilage repair procedures. They reported that high-demand athletes with OCT had superior clinical and self-reported outcome measures compared to athletes with microfracture surgery. Additionally, 93% of athletes with OCT returned to sports, compared to 52% after microfracture. At 10-year follow-up, 75% of athletes with OCT maintained their same level of sports, compared to 37% after microfracture.

II In a systematic review, Campbell et al[27] reported 20 studies involving 970 individuals on return to preinjury sport level, with 78% among athletic populations returning after articular cartilage surgeries. In patients after specific articular cartilage repair procedures, 75% returned after microfracture surgery, 84% to 86% after ACI surgeries, and 88% to 89% after OCT surgeries. The average time to return to sports was 11.2 months after articular cartilage surgical procedures. The average time to return to sports after microfracture was 8.6 months, after ACI was 16.0 months, and after OCT surgeries was 7.1 to 9.6 months. The majority of total patients (72%) returned to sports at their preinjury level, with 69% returning after microfracture, 71% to 76% after ACI, and 70% to 79% after OCT surgeries.

II In a systematic review, Filardo et al[50] reported on failure rates after ACI surgeries (5-12 years post surgery) in 193 patients. They reported that failure

rates varied based on the definition criteria: (1) surgical: the percentage of patients needing revision surgery (10.4% failure rate), (2) clinical improvement based on minimally clinically important difference (MCID) on the IKDC 2000 (21.2% failure rate), (3) absolute IKDC 2000 scores less than 60 (24.4% failure rate), or (4) IKDC clinical knee scores that were "severely abnormal" (3.6% failure rate). When all criteria were combined, the failure rate was 33.7% at a mean follow-up of 8.5 years.

II Harris et al[65] performed a systematic review of failures and reoperation rates after ACI procedures, reporting on 82 studies involving 5276 patients. They reported that the overall failure rate was 5.8%; with first-generation ACI, the failure rate was 1.5% to 7.7%, and with second-generation ACI, the failure rate was 0.83% to 3.3%. Thirty-three percent (33.3%) required a reoperation after primary ACI surgery, with a mean time to reoperation of 21.6 months.

II Chalmers et al[30] performed a systematic review of patient-reported outcomes after microfracture, osteochondral autograft, and ACI procedures from preoperation to 2 years after surgery. They reported that patients with ACI had better 1-year Tegner (4.6 versus 3.0) and 2-year IKDC 2000 (82.6 versus 72.6) scores compared to those with microfracture, whereas those with microfracture had better 1-year Lysholm (82.5 versus 73.7) scores compared to those with ACI. They reported that patients with osteochondral autograft had better 1-year Tegner (5.0 versus 3.0) scores, 2-year Marx activity rating scale (7.3 versus 3.7) scores, and 2-year SF-36 (53.5 versus 47.3) scores compared to those with microfracture, whereas those with microfracture had better 1-year Lysholm (82.5 versus 68.3) scores compared to those with osteochondral autograft.

II Howard et al[70] evaluated patient-reported outcomes in 48 (60% men) patients prior to and 3, 6, and 12 months after ACI surgery. When comparing scores prior to surgery to 6 and 12 months after surgery, mean ± SD IKDC 2000 scores improved from 38.4 ± 12.50 to 51.1 ± 18.3 and 56.2 ± 20.6, respectively; Lysholm scores improved from 47 ± 18 to 61 ± 23 and 65 ± 24, respectively; and mean WOMAC scores improved from 33 ± 17 to 22 ± 19 and 20 ± 19, respectively.

II Mithoefer et al,[99] in a systematic review, reported on 20 studies involving 1363 patients after articular cartilage repair, with a mean ± SD of 73% ± 5% of patients returning to sports. In patients after specific articular cartilage repair procedures, 66% ± 6% returned after microfracture surgery, 67% ± 17% after ACI surgeries, and 91% ± 2% after OAT surgeries. The time to return to sports varied from 7 to 18 months, depending on the surgical procedure. Time to return to sports after microfracture was 8 ± 1 months, after ACI was 18 ± 4 months, and after OAT was 7 ± 2 months. The majority of patients (68% ± 4%) returned to sports at their preinjury level, with 68% ± 5% returning after microfracture, 71% ± 12% after ACI, and 70% ± 3% after OAT.

2018 Summary

The clinical course for most patients after meniscus injury managed with or without surgery is satisfactory, though these patients will report lower knee function compared to the general population. Patients who have nonoperative management for meniscus tear have similar to better outcomes in terms of strength and perceived knee function in the short term and intermediate term compared to those who had APM.

Impairments in proprioception and muscle strength and poor patient-reported outcomes are present early after meniscal injury and in the short-term time period (less than 6 months) after APM. Most of these impairments and limitations in patient-reported outcomes may resolve within 2 years after APM. However, perceived knee function and quality of life are lower than for healthy controls as much as 4 years after APM. Demographics, meniscus tear location, physical impairments, and functional levels as determined by performance-based tests and patient-reported outcomes can influence return-to-sport rates after APM.

Young patients who have meniscus repair have similar to better perceived knee function, less activity loss, and higher rates of return to activity compared to those who have APM. Elite and competitive athletes or athletes younger than 30 years are likely to return to sport less than 2 months after APM, and athletes older than 30 years are likely to return by 3 months after APM.

Athletes with OAT procedures have a higher rate of self-reported knee function, return to sports, and maintenance of level of activity compared to athletes with ACI or microfracture.

Return to activity after ACI procedures is high, but patients are delayed in their return to sport. Failure rates and reoperation for complications after ACI procedures are high.

Microfracture procedures are most appropriate with good outcomes for small articular cartilage lesions and those returning to low-demand sports. Those with small lesions returning to high-demand sports have a progressively higher failure rate.

RISK FACTORS

2010 Recommendation

C Clinicians should consider age and greater time from injury as predisposing factors for having a meniscal injury. Patients who participated in high-level sports or had increased knee laxity after an ACL injury are more likely to have late meniscal surgery.

Clinicians should consider the patients' age and presence of a meniscal tear for the odds of having a chondral lesion subsequent to having an ACL injury. The greater a patient's age and longer time from initial ACL injury are predictive factors of the severity of chondral lesions, and time from initial ACL injury is significantly associated with the number of chondral lesions.

Evidence Update

Meniscus

II A systematic review of 11 studies of risk factors for meniscus tears found strong evidence that older age (greater than 60 years) (odds ratio [OR] = 2.32), male sex (OR = 2.98), work-related kneeling and squatting (OR = 2.69), and climbing more than 30 flights of stairs per day (OR = 2.28) were associated with the occurrence of degenerative meniscus tears.[124] Playing soccer (OR = 3.58) and rugby (OR = 2.84) were strong risk factors for acute meniscus tears. Additionally, delayed ACL reconstruction (OR = 3.50) was a strong risk factor for future medial meniscus tears.

II Papalia et al[110] performed a systematic review of 32 studies to identify risk factors of knee osteoarthritis after meniscectomy. The overall mean prevalence of knee osteoarthritis was 53.5% (range, 16%-92.9%). They found strong evidence that medial and lateral meniscectomy and duration of preoperative symptoms were associated with knee osteoarthritis. Consistent evidence was found that the extent of meniscectomy was associated with knee osteoarthritis. Incidence of knee osteoarthritis was reported higher after meniscectomy in those with degenerative meniscus tears compared to those with traumatic tears. Age at surgery, sex, duration of follow-up, cartilage status, body mass index, functional results, and impairments were inconsistent in their association with knee osteoarthritis.

II A systematic review of 5 studies with a minimum of 8-year follow-up on factors associated with knee osteoarthritis after partial meniscectomy found normal or nearly normal clinical results based on clinician grading scores, such as IKDC grading or Fairbanks grading, in 80% to 100% of patients.[113] Radiographic evidence of joint degeneration after partial meniscectomy was present in up to 60% of patients.

II Rosenberger et al[118] found that women had poorer knee function on the Lysholm scale than men until 48 weeks post APM. Among women, previous knee injury or impairment and lower preoperative fitness level were risk factors for slower postoperative recovery following partial meniscectomy for patients with meniscus tear.

II In a study of all meniscal repairs and any concomitant procedures from a New York statewide database, risk factors for meniscectomy after meniscal repairs were identified.[94] Older age (older than 40 years of age) (hazard ratio = 0.53), lateral meniscus injury (hazard ratio = 0.71), and surgeon characteristics (high annual volume of meniscus repairs) (hazard ratio = 0.37) were associated with lower likelihood of subsequent meniscectomy after an initial isolated meniscus repair.

III Brambilla et al[19] retrospectively examined the prevalence of associated meniscus and cartilage lesions in ACL reconstruction. They reported an increase of an average of 0.6% of associated lesion for each month of delay of ACL reconstruction. A delay of 12 months for ACL reconstruction increased the odds of developing a medial meniscus tear (OR = 1.81; 95% CI: 1.32, 2.48), and developing a cartilage lesion on the medial femoral condyle (OR = 2.35; 95% CI: 1.50, 3.68) and on the medial tibial plateau (OR = 5.57; 95% CI: 1.91, 16.26). Male sex increased the odds for developing lateral meniscal tears (OR = 2.29; 95% CI: 1.60, 3.28) and medial meniscal tears (OR = 1.75; 95% CI: 1.28, 2.40).

III In a retrospective analysis, Hwang et al[71] investigated the risk factors associated with medial meniscus posterior root tears. Patients with medial meniscus posterior root tears were older, more likely to be female, and had a higher body mass index (greater than 30 kg/m^2), greater varus mechanical axis angle, lower sports activity level, and higher Kellgren-Lawrence grade than patients with other types of meniscus tears.

III In a case-control study, Englund et al[47] reported that any history of meniscus tear (either traumatic or degenerative), independent of meniscectomy and adjusted for patient demographics, physical activity, and mechanical alignment, as compared to no meniscus tear, is highly predictive (OR = 5.7) of the development of radiographic tibiofemoral osteoarthritis.

III In a retrospective analysis of 1252 patients in the Kaiser Permanente Anterior Cruciate Ligament Reconstruction Registry, time from injury to ACL reconstruction of greater than 12 months increased the risk of medial meniscus injury at the time of ACL reconstruction. At

the time of ACL reconstruction, women had a lower risk of lateral meniscus injury as compared to men.[31] Increasing age and greater delay in time to ACL reconstruction increased the risk for cartilage injury at the time of ACL reconstruction. A decrease in the rate of medial meniscus repairs relative to medial meniscus injury was associated with delayed time to ACL reconstruction and increasing age.

III In a cross-sectional analysis of 2131 knees from the Multicenter Osteoarthritis Study,[35] the risk of meniscus extrusion (meniscal margin extending beyond the tibial margin) from meniscus tears in the medial compartment had an OR of 6.3 and tears in the lateral compartment had an OR of 10.3. Varus and valgus malalignment, and cartilage damage in the medial and lateral compartments, respectively, were also associated with meniscus extrusion.

IV In a retrospective analysis of 210 patients with horizontal or radial meniscus tears by Wu et al,[143] the prevalence of radial tears in the posterior horn of the medial meniscus was 25.3% and of horizontal tears in the posterior horn was 26.3%. Higher static varus angle of the knee (OR = 12.58; 95% CI: 2.83, 55.90), older age (OR = 0.88; 95% CI: 0.78, 0.94), and higher Outerbridge grade were risk factors for radial tears in the posterior horn of the medial meniscus.

IV In a retrospective analysis of 129 patients with ACL reconstruction, delay in ACL reconstruction of greater than 24 weeks was identified as a risk factor of medial, lateral, or both meniscus tears at time of surgery.[72]

Articular Cartilage

I Pestka et al[112] evaluated clinical outcomes after MACI using the IKDC 2000 questionnaire. They reported that patients with IKDC 2000 scores greater than 80 at 6 (100% probability), 12 (91% probability), and 24 months (89% probability) after surgery were more likely to have IKDC 2000 scores greater than 80 at 36 months, whereas patients with IKDC 2000 scores less than 65 at 12 (61% probability) and 24 months (81% probability) after surgery were more likely to show no improvement (IKDC 2000 score greater than 65) by 36 months.

I In a retrospective analysis of 454 patients, Salzmann et al[121] found that absence of previous knee trauma, longer symptom duration, female sex, and previous surgery to the index knee predicted lower IKDC 2000 scores in all patients undergoing microfracture surgery. In patients who failed microfracture surgery, absence of previous knee trauma, longer symptom duration, lower preoperative pain and function, smoking, and follow-up time were predictive of lower IKDC 2000 scores. Lower preoperative pain and function, smoking, and patellofemoral lesions were related to higher probability of reoperation.

I Jungmann et al, [77] in a study of 88 patients, reported that women (OR = 1.7) and having previous multiple knee surgeries (OR = 4.0), previous bone marrow stimulation procedures (OR = 1.9), and periosteum patch-covered ACI (OR = 2.0-2.4) were associated with significantly higher risk of surgical revision of the index knee.

II Ebert et al[42] performed a retrospective analysis of 104 patients (62 men; mean ± SD age, 37.9 ± 11.6 years). They reported that higher preoperative SF-36 mental and physical component summary scores, and shorter duration of symptoms, were associated with more favorable KOOS sports/recreation scores 5 years after MACI. Younger age, higher SF-36 mental component scores, shorter duration of symptoms, fewer previous knee procedures, and smaller graft size predicted better 5-year MRI scores. Earlier return to full weight bearing was associated with higher 5-year patient satisfaction scores.

III In a case-control study of 122 patients, people with a higher body mass index prior to ACI procedure were more likely to have poorer knee function as reported by the modified Cincinnati scores 24 months after surgery, independent of other demographic and lesion characteristics.[73]

Meniscus and Articular Cartilage

I In a prospective, longitudinal observational study of 152 women older than 40 years of age, Crema et al[34] reported that cartilage loss in the medial tibia (total medial tibia and external medial tibia regions) was positively associated with complex medial meniscus tears or medial meniscus maceration. However, cartilage loss in the medial femoral condyle was not associated with single medial meniscus tears.

III Kluczynski et al,[84] in a prospective case-control study of 541 patients, reported that male sex was positively associated with overall lateral meniscus tears in patients undergoing ACL reconstruction, while male sex and delayed surgery up to 6 weeks were associated with lateral meniscus tear surgical management. Male sex, obesity, sports injuries, and a greater number of instability episodes were identified as risk factors for medial meniscus tears in patients undergoing ACL reconstruction and medial meniscus tear surgical management. Older age, obesity, and delayed surgery up to 12 weeks were associated with chondral lesions in patients undergoing ACL reconstruction.

IV Among 103 patients (range, 14-85 years of age) prospectively followed, individuals with isolated root and radial/flap meniscus tears had greater articular cartilage degeneration on the medial femoral condyle.[68] Those with isolated root and complex meniscus tears had more articular cartilage degeneration on the medial tibial plateau, whereas those with isolated radial/flap meniscus tears had more articular cartilage degeneration on the lateral tibial plateau. An increase in age and body mass index decreased the Noyes lateral compartment score for a bucket handle/vertical meniscus tear, and an increase in age decreased the Noyes medial compartment score for a bucket handle/vertical meniscus tear.

IV In a case series of 97 patients, symptoms lasting more than 6 months after initial injury (OR = 4.98) and a wedge-shaped (asymmetrical) discoid lateral meniscus (OR = 5.36) were associated with the number of articular cartilage lesions as observed on arthroscopy.[40]

2018 Summary

Cutting and pivoting sports are risk factors for acute meniscus tears. Increased age and delayed ACL reconstruction are risk factors for future medial and lateral meniscus tears. Female sex, older age, higher body mass index, lower physical activity, and delayed ACL reconstruction are risk factors for medial meniscus tears. Female sex, older age, higher body mass index, longer symptom duration, previous procedures and surgeries, and lower self-reported knee function are associated with higher failures with articular cartilage repair surgical procedures.

DIAGNOSIS/CLASSIFICATION

2010 Summary

The ICD diagnosis of a meniscal tear and the associated ICF diagnosis of joint pain and mobility impairments are made with a fair level of certainty when the patient presents with the following clinical findings[9,14,21,67,93,98,119]:

- Twisting injury
- Tearing sensation at time of injury
- Delayed effusion (6-24 hours post injury)
- History of "catching" or "locking"
- Pain with forced hyperextension
- Pain with maximum passive knee flexion
- Pain or audible click with McMurray's maneuver
  - Sensitivity, 55% (95% CI: 50%, 60%)
    - Medial meniscus, 50% (95% CI: 38%, 62%)
    - Lateral meniscus, 21% (95% CI: 9%, 43%)
  - Specificity, 77% (95% CI: 62%, 87%)
    - Medial meniscus, 77% (95% CI: 57%, 90%)
    - Lateral meniscus, 94% (95% CI: 85%, 98%)
- Joint-line tenderness
  - Sensitivity, 76% (95% CI: 73%, 80%)
    - Medial meniscus, 83% (95% CI: 71%, 90%)
    - Lateral meniscus, 68% (95% CI: 46%, 85%)
  - Specificity, 77% (95% CI: 64%, 87%)
    - Medial meniscus, 76% (95% CI: 55%, 89%)
    - Lateral meniscus, 97% (95% CI: 89%, 99%)
- Discomfort or a sense of locking or catching in the knee over either the medial or lateral joint line during the Thessaly test when performed at 20° of knee flexion
  - Sensitivity
    - Medial meniscus, 59% to 89%
    - Lateral meniscus, 67% to 92%
  - Specificity
    - Medial meniscus, 83% to 97%
    - Lateral meniscus, 95% to 96%
- Meniscal Pathology Composite Score: the combination of history of "catching" or "locking," pain with forced hyperextension, pain with maximum passive knee flexion, joint-line tenderness, and pain or audible click with McMurray's maneuver
  - Greater than 5 positive findings
    - Sensitivity, 11.2%
    - Specificity, 99.0%
  - Greater than 3 positive findings
    - Sensitivity, 30.8%
    - Specificity, 90.2%
  - Greater than 1 positive finding
    - Sensitivity, 76.6%
    - Specificity, 43.1%
  - Zero positive findings
    - Sensitivity, 23.4%
    - Specificity, 56.9%

The ICD diagnosis of an articular cartilage defect and the associated ICF diagnosis of joint pain and mobility impairments are made with a low level of certainty when the patient presents with the following clinical findings[23]:

- Acute trauma with hemarthrosis (0-2 hours) (associated with osteochondral fracture)
- Insidious onset aggravated by repetitive impact
- Intermittent pain and swelling
- History of "catching" or "locking"
- Joint-line tenderness

Evidence Update

None.

2018 Summary for Diagnosing Meniscal Lesions

Clinical findings of knee pain, history of twisting knee mechanism injury, history of "catching" or "locking," delayed onset of effusion, and a Meniscal Pathology Composite Score greater than 3 positive findings may be used to classify patients with knee pain and mobility disorders into the

ICD category of tear of the meniscus and the associated ICF impairment-based categories of knee pain (**b28016 Pain in joint**) and mobility impairments (**b7100 Mobility of a single joint**).

2018 Summary for Diagnosing Articular Cartilage Lesions

The clinical findings of intermittent knee pain, history of acute trauma to the knee, history of "catching" or "locking," effusion, and joint-line tenderness may classify patients with knee pain and mobility disorders into the ICD category of tear of the articular cartilage and the associated ICF impairment-based categories of knee pain (**b28016 Pain in joint**) and mobility impairments (**b7100 Mobility of a single joint**).

Decision Tree Model

A pathoanatomical/medical diagnosis of meniscus/articular cartilage lesion can provide valuable information in describing tissue pathology and may assist in nonoperative or preoperative planning and predicting prognosis. The proposed model for examination, diagnosis, and treatment planning for patients with knee pain and mobility impairments associated with knee meniscus/articular cartilage lesions uses the following components: (1) medical screening; (2) classify the condition through evaluation of clinical findings suggestive of musculoskeletal impairments of body functioning (ICF) and associated tissue pathology/disease (ICD); (3) determination of irritability stage; (4) determination of evaluative outcome measure instruments; and (5) intervention strategies for patients with meniscus/articular cartilage lesions with respect to postsurgical care. This model is depicted in the **FIGURE**.

Component 1

Medical screening incorporates the findings of the history and physical examination to determine whether the patient's symptoms originate from a condition that requires referral to another health care provider. The Ottawa knee rules are one example of tools that may be helpful in this decision-making process. In addition to those conditions that require a provider referral, clinicians should screen for the presence of psychosocial issues that may affect prognosis and rehabilitation treatment decision making. Psychological stress negatively influences recovery. Fear of reinjury is a frequently cited reason that athletes do not return to sport or reduce their level of physical activity.[5,6] Low internal health locus of control (the belief in one's ability to control one's life), lower self-efficacy, and depressive symptoms prior to surgery result in worse outcomes after ACL reconstruction.[53,131] Athletes who did not return to sport after ACL reconstruction had significantly lower preoperative motivation and more negative psychological response than those who did return.[7] Accordingly, identifying cognitive behavioral tendencies during the patient's evaluation can direct the therapist to employ specific patient education strategies to optimize patient outcomes from physical therapy interventions and potentially provide indications for referring the patient for consultation with another medical or mental health practitioner.[15]

Component 2

Differential evaluation of musculoskeletal clinical findings is to determine the most relevant physical impairments associated with the patient's reported activity limitations and medical diagnosis.[79] Clusters of these clinical findings are described as impairment patterns in the physical therapy literature, and are labeled according to the key impairment(s) of body function associated with that cluster. The ICD-10 and primary and secondary ICF codes associated with meniscus/articular cartilage lesions are provided in the 2010 ICF-based meniscus/articular cartilage lesions CPG.[91] These impairment patterns impact the selection of interventions, which focus on normalizing the key impairments of body function, which in turn improves the movement and function of the patient and lessens or alleviates the activity limitations commonly reported by the patients who meet the diagnostic criteria of that specific pattern. The **FIGURE** lists the key clinical findings used to rule in or rule out the common impairment patterns, and their associated medical conditions. Impairment-based classification is critical for matching the intervention strategy that is most likely to provide the optimal outcome for a patient's clinical findings.[79] However, it is important for clinicians to understand that the impairment pattern, the most relevant impairments of body function, and the associated intervention strategies often change during the patient's episode of care. Thus, continual re-evaluation of the patient's response to treatment and the patient's emerging clinical findings are important for providing optimal interventions throughout the patient's episode of care.[17]

Component 3

Irritability is a term used by rehabilitation practitioners to reflect the tissue's ability to handle physical stress,[101] and is presumably related to physical status and the extent of injury and inflammatory activity that is present. There are cases where the irritability level and the duration of symptoms do not match, requiring clinicians to make judgments when applying time-based research results to individual patients.[17] Diagnosis of tissue irritability is important for guiding the clinical decisions regarding treatment frequency, intensity, duration, and type, with the goal of matching the optimal dosage of treatment to the status of the tissue being treated.[17,79] There are other biopsychosocial elements that may relate to staging of the condition, including, but not limited to, the level of disability reported by the patient and activity avoidance.[32]

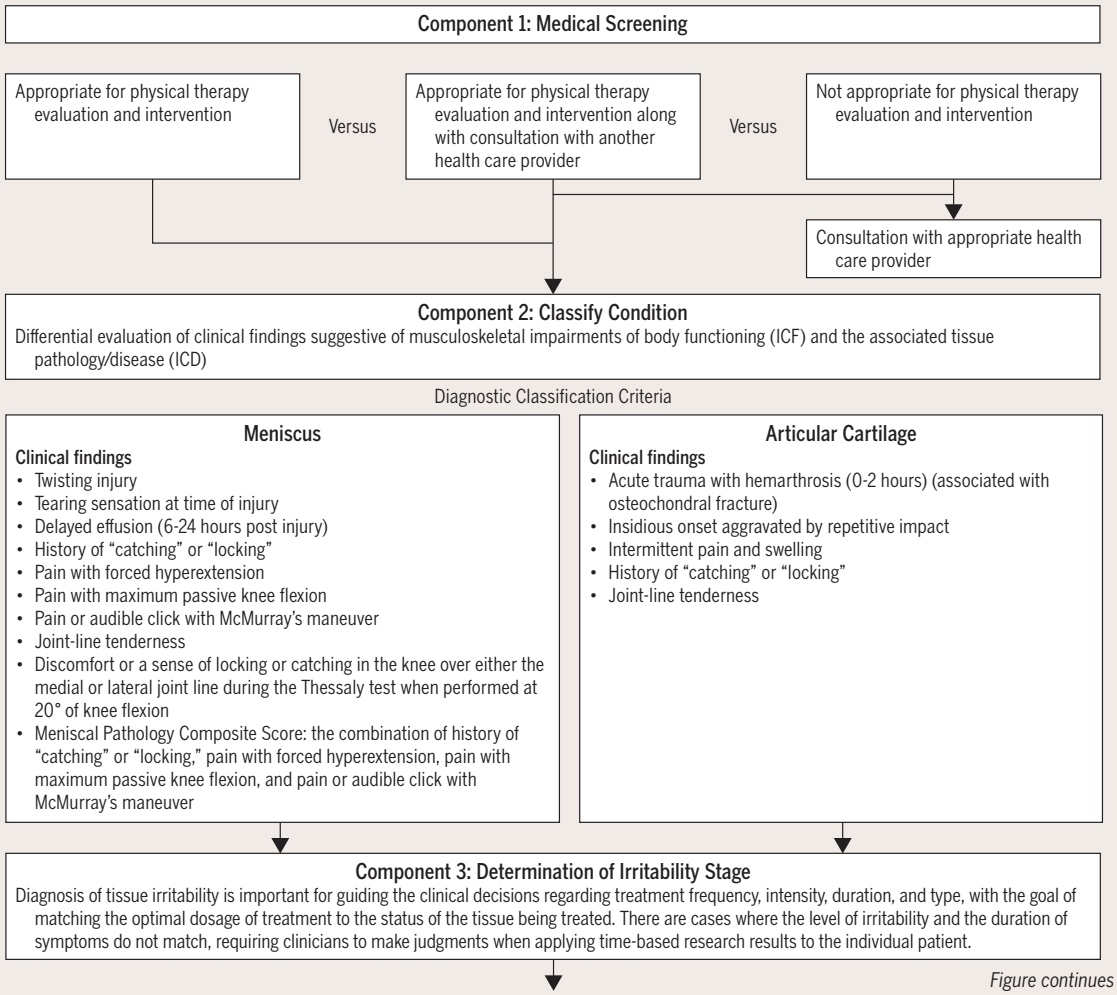

Figure continues on page A18.

FIGURE. Model of diagnosis, examination, and treatment of knee pain and mobility impairments. A, guidelines based on strong evidence; B, guidelines based on moderate evidence; C, guidelines based on weak evidence; D, conflicting evidence; E, guidelines based on theoretical/foundational evidence; F, guidelines based on expert opinion.

Component 4

Outcome measures are standardized tools used for measuring a specific domain, whether it is a body structure or function, activity limitation, or participation restriction, or for determining a specific end point. They are important in direct management of individual patient care, and they provide the opportunity to collectively compare care and determine effectiveness through the repeated application of a standardized measurement. Outcomes in clinical practice provide the mechanism by which the health care provider, the patient, the public, and the payer are able to assess the end results of care and its effect upon the health of the patient and society. Outcome measurement can identify baseline pain, function, and disability, assess global knee function, determine readiness to return to activities, and monitor changes in status throughout treatment. Outcome measures can be classified as patient-reported outcome measures, physical performance measures, and physical impairment measures.

Component 5

Tear pattern of the meniscus or the size of the articular cartilage lesion and clinical signs and symptoms have typically guided the clinical decision making of treatment interventions primarily for the type of surgical intervention. Interventions are listed by phase of rehabilitation (early, early to late phase). Because irritability level often reflects the tissue's ability to accept physical stress, clinicians should match the most appropriate intervention strategies to the irritability level of the patient's condition.[17,79] Additionally, clinicians should consider influences from psychosocial factors[5-7] in patients with conditions in all stages of recovery.

DIFFERENTIAL DIAGNOSIS

2010 and 2018 Summary

Clinicians should consider diagnostic classifications associated with serious pathological conditions or psychosocial factors when the patient's reported activity limitations or impair-

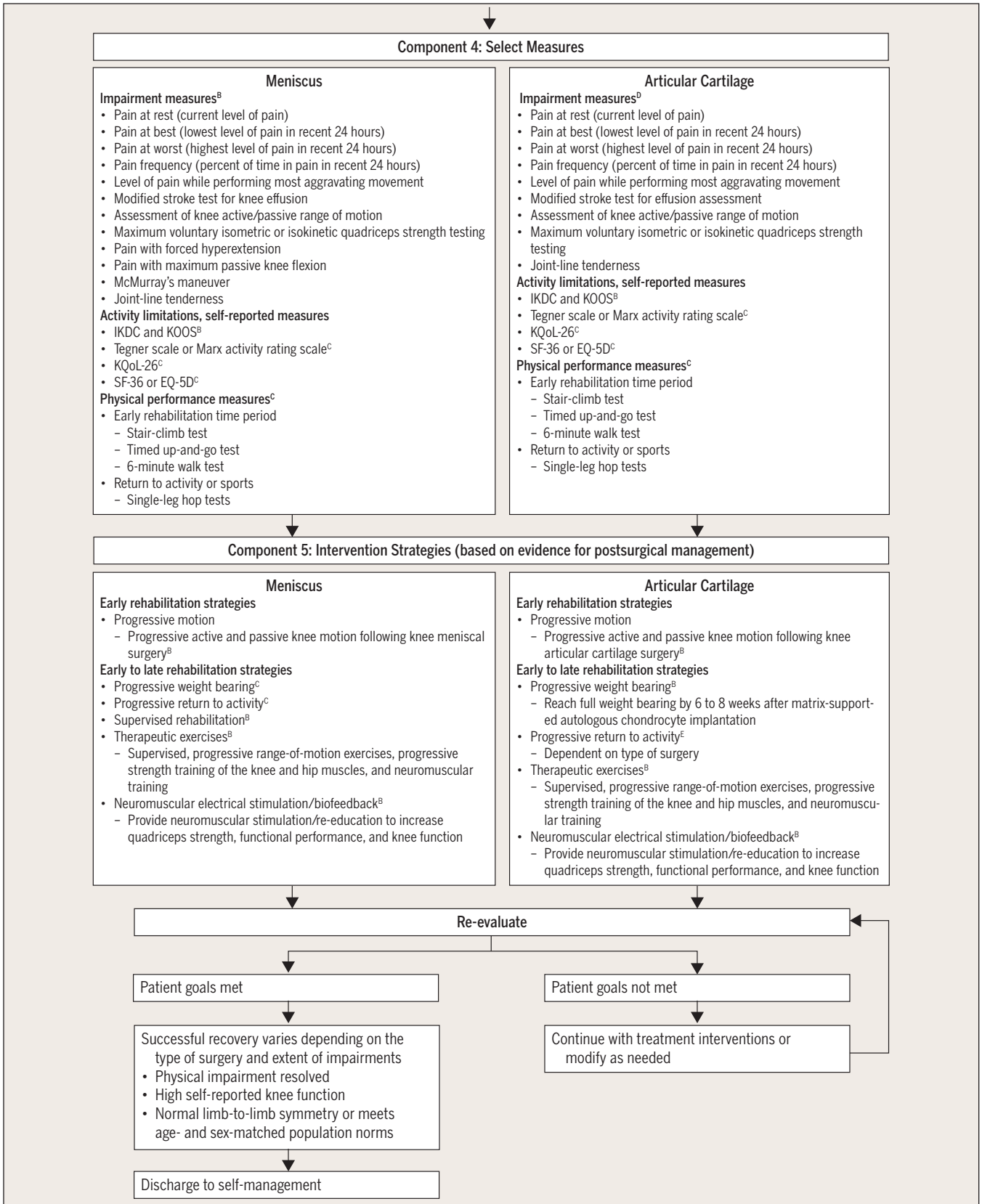

FIGURE (CONTINUED). Model of diagnosis, examination, and treatment of knee pain and mobility impairments. A, guidelines based on strong evidence; B, guidelines based on moderate evidence; C, guidelines based on weak evidence; D, conflicting evidence; E, guidelines based on theoretical/foundational evidence; F, guidelines based on expert opinion.

ments of body function and structure are inconsistent with those presented in the diagnosis/classification section of this guideline, or when the patient's symptoms are not resolving with appropriate interventions.

IMAGING STUDIES

2010 and 2018 Summary (unchanged from 2010)

When a patient reports a history of knee trauma, the therapist needs to be alert for the presence of a fracture in associated lower extremity bones. The Ottawa knee rule has been developed and validated to assist clinicians in determining when to order radiographs in individuals with acute knee injury.[12,127] The Ottawa knee rule has a sensitivity of 0.99 and specificity of 0.49.[12] A knee radiograph series is required in patients with any of the following criteria:

- Aged 55 years or older
- Isolated tenderness of patella (no bone tenderness of knee other than patella)
- Tenderness of head of the fibula
- Inability to flex knee to 90°
- Inability to bear weight both immediately and in the emergency department for 4 steps regardless of limping

Clinical examination by well-trained clinicians appears to be as accurate as MRI in regard to the diagnosis of meniscal lesions.[10,85,95] A lower threshold of suspicion of a meniscal tear is warranted in middle-aged and elderly patients.[59,95] Magnetic resonance imaging may be reserved for more complicated or confusing cases[85] and may assist an orthopaedic surgeon in preoperative planning and prognosis.[85,95] Imaging may be used to monitor the status of meniscus repair or articular cartilage repair or restoration procedures.[25,104]

CLINICAL GUIDELINES

Examination

OUTCOME MEASURES – ACTIVITY LIMITATIONS/ SELF-REPORTED MEASURES

2010 Recommendation

B Clinicians should use a validated patient-reported outcome measure, a general health questionnaire, and a validated activity scale for patients with knee pain and mobility impairments. These tools are useful for identifying a patient's baseline status relative to pain, function, and disability and for monitoring changes in the patient's status throughout the course of treatment.

Evidence Update

II The KOOS has been evaluated for its reliability and validity in people with articular cartilage lesions.[45] Using qualitative methodology, content validity of the KOOS was demonstrated in people who had undergone, or were candidates for, articular cartilage repair. In the quantitative analysis, KOOS subscales showed test-retest reliability (all intraclass correlation coefficients [ICCs] greater than 0.70), and construct validity was demonstrated against the SF-36, although correlation between the KOOS quality of life subscale and SF-36 general health was nonsignificant. The KOOS showed sensitivity to change from baseline to 12 months after baseline, with standardized response means from 0.8 to 1.2 and minimal detectable change estimates ranging between 7.4 and 12.1.

II The psychometric properties (internal consistency, convergent validity, sensitivity to change, and floor and ceiling effects) of the generic European Quality of Life-5 Dimensions (EQ-5D) and Medical Outcomes Study Short Form-6 Dimensions (SF-6D) were compared to the knee-specific Hughston Clinic Questionnaire (HCQ) in 84 patients on average 5 days, 6 weeks, and 6 months following APM.[56] The EQ-5D was more consistently responsive to change over time, was better at distinguishing differences between groups, and better reflected the results of the joint-specific HCQ than the SF-6D. Thus, in this patient population, the EQ-5D is preferable to the SF-6D when used alongside a knee-specific instrument such as the HCQ.

II The Knee Quality of Life 26-item questionnaire (KQoL-26) for patients with a suspected ligamentous or meniscal injury contains 26 items with 3 subscales of knee-related quality of life: physical functioning, activity limitations, and emotional functioning.[54] The KQoL-26 was found to have evidence for internal reliability (Cronbach α = .91-.94), test-retest reliability (estimates of 0.80-0.93), construct validity (correlations with other knee scales including Lysholm knee scale: r = 0.58-0.76 with the 3 KQoL-26 subscales; EQ-5D questionnaire: r = 0.21-0.54 with the 3 KQoL-26 subscales; SF-36: r = 0.39-0.64 with the 3 KQoL-26 subscales; and knee symptom questions), responsiveness (effect size: KQoL-26, 0.86-1.13; EQ-5D, 0.46; SF-36, 0.03-0.65 and responsiveness index: KQoL-26, 1.50-2.13; EQ-5D, 0.51; SF-36, 0.03-1.12).

III The KOOS has been cross-culturally adapted for use in both the Persian and Arabic languages. In patients from Iran with ACL, meniscus, and combined meniscus and ACL injuries, the Persian version had test-retest reliability (ICCs) on all subscales greater than 0.70, except the KOOS sports/recreation subscale (ICC = 0.61), and the Persian KOOS had good construct validity against the SF-36.[120] The Arabic version showed test-retest reliability (ICCs) for all subscales above 0.70, as well as construct validity against subscales of the RAND-36 (Arabic version of SF-36) (r = 0.61-0.78) scores of pain in people from Egypt with ACL, meniscus, and combined knee injuries.[4]

III The measurement properties of the Dutch-language versions of the IKDC 2000, KOOS, and WOMAC were compared in patients with meniscal tears.[136] The Cronbach alpha for the IKDC 2000 was .90, for KOOS was .97, for KOOS domains was .72 to .95, for WOMAC was .96, and for WOMAC domains was .84 to .95. Test-retest reliability for the IKDC 2000 was 0.93 (95% CI: 0.89, 0.96), for KOOS was 0.93 (95% CI: 0.89, 0.96), and for WOMAC was 0.89 (95% CI: 0.83, 0.93). The standard error of the measurement for the IKDC 2000 was 5.3, for KOOS was 5.4, and for WOMAC was 7.2. The IKDC 2000, KOOS, and WOMAC demonstrated little to no floor or ceiling effects. The KOOS and WOMAC domains performed suboptimally with respect to internal consistency, measurement error, ability to measure true change, and content validity.

III In a study of 53 individuals obtained from a sports injury database and electronic medical records system, Balain et al[13] investigated response shift in 3 self-report measures: Lysholm scale, VAS for worst pain, and the modified IKDC 2000 scale. When patients were asked to retrospectively rate their preoperative knee function 6 months following microfracture, retrospective ratings were lower on all 3 scales than ratings completed preoperatively,

suggesting that preoperative disability may have been greater than patients realized prior to surgery. However, adjusting for this response shift did not affect the clinical interpretation of the modified IKDC 2000 scales or the Lysholm scale.

III A Rasch model was used to assess the internal construct validity of the Lysholm knee scale in 157 patients with chondral pathology.[123] Fit to the Rasch model with 7 remaining items was achieved after removal of the swelling item. There was a high degree of agreement between the patient and health professional scoring (ICC = 0.90). By removing the swelling item and using unweighted scores, a modified version of the Lysholm knee scale can be used as an outcome measure for knee chondral damage.

III A study translated and culturally adapted the Western Ontario Meniscal Evaluation Tool (WOMET) into Turkish and evaluated the reliability and validity of the translated tool in 96 patients with meniscal pathology.[29] Validity of the tool was compared against the Lysholm knee scale and the SF-36. The WOMET had a Cronbach alpha of .89. Test-retest reliability of the Turkish version of the WOMET was r = 0.80 to 0.87, and had correlations with the Lysholm knee scale (r = 0.49) and SF-36 physical component and physical scores (r = 0.39-0.63). Lower correlations were observed with several SF-36 domains, predominantly mental component and emotional role scores (r = 0.03-0.11).

III A cross-cultural adaptation of the KOOS into Spanish was evaluated in 20 patients who underwent arthroscopic surgery for knee cartilage defects with a microfracture technique.[137] Validity was assessed against the SF-36. The Spanish KOOS demonstrated adequate test-retest reliability, with ICCs exceeding 0.8 for all domains. Agreement between the Spanish-version KOOS and the SF-36 domains of physical function (r = 0.54-0.81) and pain was observed.

2018 Recommendation

B For knee-specific outcomes, clinicians should use the IKDC 2000 or KOOS (or a culturally appropriate version for patients whose primary language is not English) and may use the Lysholm scale (with removal of the swelling item, and using unweighted scores).

C Clinicians may use the Tegner scale or Marx activity rating scale to assess activity level before and after interventions intended to alleviate the physical impairments, activity limitations, and participation restrictions associated with meniscus or articular cartilage lesions; however, these have less evidence support about measurement properties. The SF-36 or the EQ-5D are appropriate general health measures in this population. The KQoL-26 may be used to assess knee-related quality of life.

PHYSICAL PERFORMANCE MEASURES

Refer to the 2010 Knee Pain and Mobility Impairments CPG for a list of activity limitation measures and their measurement properties.[91]

2010 Recommendation

C Clinicians should utilize easily reproducible physical performance measures, such as single-limb hop tests, 6-minute walk test, or timed up-and-go test, to assess activity limitations and participation restrictions associated with their patient's knee pain or mobility impairment and to assess the changes in the patient's level of function over the episode of care.

Evidence Update

None.

2018 Recommendation

C Clinicians may administer appropriate clinical or field tests, such as single-legged hop tests (eg, single hop for distance, crossover hop for distance, triple hop for distance, and 6-m timed hop), that can identify a patient's baseline status relative to pain, function, and disability; detect side-to-side asymmetries; assess global knee function; determine a patient's readiness to return to activities; and monitor changes in the patient's status throughout the course of treatment.

PHYSICAL IMPAIRMENT MEASURES

Refer to the 2010 Knee Pain and Mobility Impairments CPG for a list of physical impairment measures and their measurement properties.[91]

Evidence Update

II A systematic review of 4 articles examined the validity and reliability of tests to assess meniscus tears.[37] They reported that the Thessaly test had fair reliability (κ = 0.54) based on 1 study of moderate quality. The McMurray and joint-line-tenderness tests had poor reliability ($\kappa \leq 0.38$) based on 3 studies of low to moderate quality.

II In a large diagnostic study of 292 patients with knee pathology and 75 healthy controls, Blyth et al[18] examined the diagnostic accuracy of several meniscal tear clinical tests compared to MRI in primary care clinicians. McMurray's test had poor to fair diagnostic accuracy, with sensitivity of 0.58 (95% CI: 0.49, 0.67), specificity of 0.56 (95% CI: 0.45, 0.66), and OR of 1.79 (95% CI: 1.04,

3.09) compared to MRI. The Thessaly test had sensitivity of 0.66 (95% CI: 0.57, 0.74), specificity of 0.39 (95% CI: 0.29, 0.50), and OR of 1.24 (95% CI: 0.71, 2.18) compared to MRI. Apley's test had sensitivity of 0.53 (95% CI: 0.44, 0.62), specificity of 0.53 (95% CI: 0.42, 0.63), and OR of 1.24 (95% CI: 0.73, 2.12) compared to MRI. The joint-line-tenderness test had sensitivity of 0.77 (95% CI: 0.68, 0.84), specificity of 0.26 (95% CI: 0.18, 0.36), and OR of 1.16 (95% CI: 0.63, 2.13) compared to MRI.

III Haviv et al[66] investigated the accuracy of joint-line tenderness of meniscus tears in 134 men and 61 women. Joint-line tenderness for medial and lateral meniscus tears in men had sensitivity of 0.50 to 0.58, specificity of 0.74 to 1.00, and diagnostic accuracy of 0.63 to 0.86. Joint-line tenderness for medial and lateral meniscus tears in women had sensitivity of 0.40 to 0.49, specificity of 0.71 to 0.98, and diagnostic accuracy of 0.57 to 0.93.

III Snoeker et al[125] investigated the reliability and diagnostic accuracy of deep squat, Thessaly test, and the joint-line-tenderness test. The Thessaly test had a kappa of 0.54, sensitivity of 0.52 to 0.67, specificity of 0.38 to 0.44, positive likelihood ratio of 0.91 to 1.07, and negative likelihood ratio of 0.88 to 1.12. The deep squat test had a kappa of 0.46, sensitivity of 0.75 to 0.77, specificity of 0.36 to 0.42, positive likelihood ratio of 1.20 to 1.29, and negative likelihood ratio of 0.60 to 0.64. The joint-line-tenderness test had a kappa of 0.17.

IV Campbell et al[28] examined the association between patients' pain symptom location and arthroscopy findings in patients with meniscus tear. They reported that pain symptom location was not correlated with the location of the meniscus tear.

2018 Recommendation

B Clinicians should administer appropriate physical impairment assessments of body structure and function, at least at baseline and at discharge or 1 other follow-up point, for all patients with meniscus tears to support standardization for quality improvement in clinical care and research, including the modified stroke test for effusion assessment, assessment of knee active range of motion, maximum voluntary isometric or isokinetic quadriceps strength testing, forced hyperextension, maximum passive knee flexion, McMurray's maneuver, and joint-line tenderness to palpation.

D Clinicians may administer the appropriate physical impairment assessments of body structure and function, at least at baseline and at discharge or 1 other follow-up point, for all patients with articular cartilage lesions to support standardization for quality improvement in clinical care and research, including the modified stroke test for effusion assessment, assessment of knee active range of motion, maximum voluntary isometric or isokinetic quadriceps strength testing, and joint-line tenderness to palpation.

BEST-PRACTICE POINT

Essential Data Elements

Clinicians should document the following measures, at least at baseline and discharge or at 1 other follow-up point, for all patients with meniscus tears to support standardization for quality improvement in clinical care and research:

Activity Limitation – Self-report Measures
- IKDC 2000 and KOOS

Activity Limitation – Physical Performance Measures
- Early rehabilitation time period
  - 30-second chair-stand test
  - Stair-climb test
  - Timed up-and-go test
  - 6-minute walk test
- Return to activity or sports
  - Single-leg hop tests

Physical Impairment Measures
- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Forced hyperextension
- Maximum passive knee flexion
- McMurray's maneuver
- Joint-line tenderness

Clinicians should document the following measures, at least at baseline and discharge or at 1 other follow-up point, for all patients with articular cartilage lesions to support standardization for quality improvement in clinical care and research:

Activity Limitation – Self-report Measures
- IKDC 2000 and KOOS

Activity Limitation – Physical Performance Measures
- Early rehabilitation time period
  - 30-second chair-stand test
  - Stair-climb test
  - Timed up-and-go test
  - 6-minute walk test
- Return to activity or sports
  - Single-leg hop tests

Physical Impairment Measures
- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Joint-line tenderness

CLINICAL GUIDELINES

Interventions

PROGRESSIVE KNEE MOTION

2010 Recommendation

C Clinicians may utilize early progressive knee motion following knee meniscal and articular cartilage surgery.

Evidence Update

II In a randomized controlled trial, patients randomized to the supervised active-range-of-motion group (n = 14) using an adjustable pedal arm stationary cycle ergometer had significantly better gait measures (presence or absence of antalgic gait and limp during gait) early after partial meniscectomy compared to the control group (n = 14) who did not have supervised therapy.[80] No differences were reported between the groups over time in range of motion, effusion, or IKDC 2000 scores.

II A systematic review of 4 level III studies on clinical effectiveness of continuous passive motion after articular lesion surgery did not find improved histological outcomes on second-look arthroscopic biopsies or improved radiographic findings greater than 1 year after surgery.[49] Mixed results in clinical outcomes were reported between the continuous passive motion groups and the active-range-of-motion groups.

2018 Recommendation

B Clinicians may use early progressive active and passive knee motion with patients after knee meniscal and articular cartilage surgery.

PROGRESSIVE WEIGHT BEARING

2010 Recommendation

D There are conflicting opinions regarding the best use of progressive weight bearing in patients with meniscal repairs or chondral lesions.

Evidence Update

I Ebert et al[41] randomized 62 patients after MACI to an accelerated weight-bearing group (stepwise progression in weight bearing, with full weight bearing by 8 weeks) or to a standard of care weight-bearing group (5 weeks of 20% partial weight bearing followed by stepwise progression in weight bearing, with full weight bearing by week 11). Three months after MACI, patients in the accelerated group had better KOOS scores compared to those in the standard of care group (range for KOOS subscales: 11.84 to 83.32 versus 6.82 to 78.55). Both groups demonstrated progressive graft tissue healing over time, with no difference between groups at any time period (no complete graft de-lamination).

I Twenty-eight consecutive patients after MACI were randomized to an accelerated weight-bearing group (stepwise progression in weight bearing, with full weight bearing by 6 weeks) (n = 14) or to a standard of care weight-bearing group (stepwise progression in weight bearing, with full weight bearing by 8 weeks) (n = 14).[43] Six and 12 months after MACI, patients in the accelerated group had better KOOS quality of life scores compared to those in the standard of care group (6 months, 62 versus 50; 12 months, 77 versus 58). Both groups demonstrated progressive graft tissue healing over time, with no difference between groups at any time period.

I Thirty-one patients after ACI were randomized to an accelerated weight-bearing group (stepwise progression in weight bearing, with full weight bearing after 6 weeks) or to a standard of care weight-bearing group (stepwise progression in weight bearing, with full weight bearing after 8 weeks).[141] Both groups showed improvement in clinical scores (IKDC 2000 and Tegner scale) and MRI scores over 2 years, but no significant differences between groups were noted at 1 year and 2 years after ACI.

II Lind et al[90] randomized 60 patients after isolated meniscal repair to receive either free rehabilitation (restricted range of motion and toe-touch weight bearing and no brace for 2 weeks with unrestricted activity and free range of motion afterward) or restricted rehabilitation (braced toe-touch weight bearing and progressive restricted range of motion for 6 weeks). Patients were followed at 3 months and 1 and 2 years on KOOS and Tegner measures. Patients who underwent repeat arthroscopy demonstrated little to partial healing in approximately one third of patients in each group (n = 19). The KOOS and Tegner scores were similar in both groups at 1 and 2 years.

IV A retrospective analysis of 34 patients with degenerative medial meniscus tear and knee osteoarthritis using a foot-worn biomechanical device during activities of daily living was assessed before use and 3 months

and 12 months after wearing the device.[44] Using a gait mat, patients had significant improvement in gait velocity, step length, and single-limb support of the involved knee and improved limb symmetry 3 months after device use. These results were maintained 12 months after device use.

2018 Recommendation

C Clinicians may consider early progressive weight bearing in patients with meniscal repairs.

B Clinicians should use a stepwise progression of weight bearing to reach full bearing by 6 to 8 weeks after MACI for articular cartilage lesions.

PROGRESSIVE RETURN TO ACTIVITY

2010 and 2018 Recommendation

C Clinicians may utilize early progressive return to activity following knee meniscal repair surgery.

E Clinicians may need to delay return to activity depending on the type of articular cartilage surgery.

SUPERVISED REHABILITATION

2010 Recommendation

D There are conflicting opinions regarding the best use of clinic-based programs for patients following meniscectomy to increase quadriceps strength and functional performance.

Evidence Update

II A systematic review of 18 RCTs and meta-analysis of 6 RCTs conducted by Dias et al[39] supports the utilization of outpatient physical therapy with a home exercise program compared to a home exercise program alone to improve knee range of motion and self-reported knee function and reduce knee joint effusion in patients after APM. However, the studies were of moderate to high risk of bias.

II In a systematic review of 12 articles conducted by Reid et al,[116] supervised clinic-based rehabilitation or a well-structured home exercise program demonstrated improvements in knee muscle performance and knee function early after partial meniscectomy. However, the evidence is limited on the use of exercise to prevent the development of osteoarthritis or total knee joint arthroplasty.

II In a systematic review by Coppola and Collins,[33] 5 RCTs were identified comparing outcomes of home-based versus supervised outpatient rehabilitation after meniscectomy. In early and intermediate follow-ups, there was no difference between groups in patient-reported outcomes at 3 weeks and 1 year after meniscectomy. However, the mean scores for these groups were lower than the population norm, which may suggest that patients in both groups were not fully rehabilitated. Two studies[100,138] reported on higher vertical jump height and single hop distances in the supervised rehabilitation group (vertical jump, 22.5 cm; single hop, 113.8 cm) compared to the home-based group (vertical jump, 20.1 cm; single hop distance, 94.7 cm), though both studies had short follow-ups (less than 4 weeks).

II Papalia et al,[111] in a systematic review, evaluated the same 5 RCTs as Coppola and Collins,[33] comparing outcomes between home-based versus supervised outpatient rehabilitation after meniscectomy. They reached similar conclusions that differences were demonstrated in performance-based outcomes (vertical jump height, single hop distance, and knee extensor strength), but not in patient-reported outcomes (Lysholm scale, Tegner score, Hughston questionnaire).

2018 Recommendation

B Clinicians should use exercises as part of the in-clinic supervised rehabilitation program after arthroscopic meniscectomy and should provide and supervise the progression of a home-based exercise program, providing education to ensure independent performance.

THERAPEUTIC EXERCISES

2010 Recommendation

B Clinicians should consider strength training and functional exercise to increase quadriceps and hamstrings strength, quadriceps endurance, and functional performance following meniscectomy.

Evidence Update

I Østerås[107] randomized 42 participants after degenerative meniscectomy to receive either 12 weeks of specialized exercise therapy (n = 22) or no exercise therapy (n = 20). Four participants (2 in each group) were lost to follow-up. Improvements in pain (VAS, 1.9), muscle strength (quadriceps peak torque, 38.1 Nm), and KOOS scores (18.0 points) were significantly higher in the specialized exercise therapy group compared to the no-exercise-therapy group (VAS, 0.6; quadriceps peak torque, 10.4 Nm; KOOS, 6.5) after the intervention period and 12 months later.

I In a similar study, Østerås et al[108] randomized 75 participants with degenerative meniscus tear to receive either 12 weeks of specialized exercise

therapy (n = 38) or no physical therapy (n = 37). Eleven participants (5 in the exercise group, 6 in the no-therapy group) were lost to follow-up. Improvements in pain, muscle strength, and patient-reported measures were significantly higher in the exercise therapy group compared to the no-therapy group after the intervention period and 12 months later.

I Assche et al[11] implemented the same standardized rehabilitation protocol to patients who were initially randomized into an ACI surgery group (n = 57) or a microfracture surgery group (n = 61). Both groups received the same rehabilitation program consisting of progressive, stepwise weight bearing, joint mobilization exercises, progressive strength training to the knee muscles, neuromuscular training, and return-to-sports integration. The authors reported no differences in recovery between the 2 groups at 2-year follow-up. When assessing patient recovery, activities that were repetitive movements in low-load conditions (range of motion, non–weight-bearing strengthening exercises, proprioceptive exercises) were considered low-load modalities. Patients who had low levels of activity (less than 12 minutes per day of activity) in these low-load modalities had poorer outcomes in quadriceps strength and single-legged hop performance than patients who had high levels of activity (greater than 12 minutes per day of activity) in low-load modalities.

I Hall et al[60] performed an RCT to investigate the effects of a neuromuscular training program on knee kinetics, cartilage quality, and physical function during walking and single-legged sit-to-stand after APM. Groups were randomly assigned to the neuromuscular training group or a control group receiving no interventions. The authors reported no differences in peak knee adduction moment, cartilage quality, and physical function. The neuromuscular group was more likely to demonstrate improvements in physical function and overall improvement compared to the control group.

I Kise et al[83] randomized 140 participants into 2 treatment groups: exercise therapy (n = 70) or APM. Thirteen (19%) of 70 participants crossed over to the APM group and were analyzed in the "as treated group." The authors reported no clinically relevant differences in KOOS change scores from baseline to 2-year follow-up between groups (0.9 points; 95% CI: −4.3, 6.1). Both groups demonstrated similar improvements from baseline to 2-year follow-up (exercise group, 25.3 points; 95% CI: 21.6, 29.0 and APM group, 24.4 points; 95% CI: 20.7, 28.0). The exercise group had greater improvement in muscle strength at 3 and 12 months (P<.03).

II Koutras and colleagues[86] randomized 20 male patients after APM to either receive standard rehabilitation augmented with progressive isokinetic muscle strength training or progressive isotonic muscle strength training. Both groups demonstrated a significant improvement in knee extensor and flexor isokinetic strength and single-legged hop limb-to-limb symmetry (knee extensor at 60°/s, 17% improvement; knee flexor at 60°/s, 12% improvement; single hop: 14% improvement; triple hop: 17% improvement; vertical hop: 18% improvement) and in Lysholm scores (17% improvement) over time, but no significant differences were noted between groups.

II Lind et al[90] randomized 60 patients after isolated meniscal repair to receive either free rehabilitation (restricted range of motion and toe-touch weight bearing and no brace for 2 weeks with unrestricted activity and free range of motion afterward) or restricted rehabilitation (braced toe-touch weight bearing and progressive restricted range of motion for 6 weeks). Patients were followed at 3 months and 1 and 2 years on KOOS and Tegner measures. Patients who underwent repeat arthroscopy demonstrated little to partial healing in approximately one third of patients in each group (n = 19). The KOOS and Tegner scores were similar in both groups at 1 and 2 years.

III Della Villa et al[38] evaluated an intensive rehabilitation program in 31 highly competitive male athletes after an ACI procedure compared to a standard program in 34 nonathletic participants after the same ACI procedure. They reported that at 1 year post surgery, the athletic cohort had higher IKDC 2000 scores than the nonathletic cohort (mean ± SD, 84.7 ± 11.7 versus 71.3 ± 16.9), and at 5 years (90.7 ± 11.7 versus 75.7 ± 22.4). Both groups had a decrease in Tegner scores from preinjury to 5 years follow-up (athletic cohort: preinjury, 8.3 ± 1.2; 5 years, 7.3 ± 1.6 and nonathletic cohort: preinjury, 5.9 ± 1.3; 5 years, 4.3 ± 2.1). No severe adverse events were reported in either cohort.

IV In a retrospective study, 30 patients with nontraumatic posterior root tear of the medial meniscus had supervised physical therapy, focusing on knee range of motion and knee muscle strength for at least 8 weeks, and were prescribed nonsteroidal anti-inflammatory drugs for 8 to 12 weeks.[89] Patients demonstrated significant and clinically meaningful improvements in pain levels (4-point improvement on VAS) and self-reported knee function (13-point improvement in Lysholm scores).

IV Neogi et al[102] reported benefit in symptoms and function with 12-week rehabilitation and analgesics (up to 6 weeks) in 37 patients with degenerative

meniscus. Patients demonstrated improvements in Lysholm scores from pretreatment to final follow-up (56 to 79), Tegner scores (2 to 4), and VAS of pain at rest (2 to 0). Despite the improvement, the number of participants with radiographic osteoarthritis had increased by the final follow-up from 24 knees with Kellgren-Lawrence classifications at grades 0 and 1 and 9 knees at stage 2 or greater at pretreatment to 12 knees with grade 0 and 1 and 21 knees at stage 2 or greater at final follow-up.

IV Forty-eight patients with full-thickness articular cartilage lesions with poor knee function participated in a 3-month rehabilitation program consisting of cardiovascular training, progressive strength training of the knee and hip muscles, and neuromuscular training.[140] Primary outcome measures were KOOS and IKDC 2000 scores, and isokinetic muscle strength and hop test scores. The authors reported an 83% adherence rate to the rehabilitation program. They reported clinically significant increases in KOOS sports/recreation and KOOS quality of life subscales. Patients also had large positive effects in standardized response means for muscle strength (0.99 to 1.22) and hop performance (0.53 to 0.75). Four (8.3%) patients showed increases in pain and effusion.

2018 Recommendation

B Clinicians should provide supervised, progressive range-of-motion exercises, progressive strength training of the knee and hip muscles, and neuromuscular training to patients with knee meniscus tears and articular cartilage lesions and after meniscus or articular cartilage surgery.

NEUROMUSCULAR ELECTRICAL STIMULATION/BIOFEEDBACK

2010 Recommendation

B Neuromuscular electrical stimulation can be used with patients following meniscal or chondral injuries to increase quadriceps muscle strength.

Evidence Update

II Akkaya et al[2] conducted a 3-arm RCT in 45 patients after APM comparing (1) a home exercise program (without any biofeedback or electrical stimulation), (2) electromyographic biofeedback to the quadriceps plus a home exercise program, and (3) electrical stimulation to the quadriceps plus a home exercise program. All 3 groups had similar gait measures and muscle performance values (no statistical differences between groups) 2 and 6 weeks after surgery. All groups had significant improvement in pain during walking and Lysholm scores early after partial meniscectomy.

II In an RCT, 64 participants were randomized to receive either electromyographic biofeedback (n = 33) or usual care (n = 31) early after meniscal repair.[106] Electromyographic values and KOOS sport/recreation scores were significantly better in the biofeedback group (electromyographic, 16% to 25% higher; KOOS sport/recreation, 6% higher) compared to the usual care group 8 weeks after meniscal repair. However, these differences may not be clinically meaningful.

2018 Recommendation

B Clinicians should provide neuromuscular stimulation/re-education to patients following meniscus procedures to increase quadriceps strength, functional performance, and knee function.

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APPENDIX A

SEARCH STRATEGIES FOR ALL DATABASES SEARCHED

MEDLINE

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (classif* [TW])

((“Menisci, Tibial”[MH]) OR (knee joint[MH] AND (menisc*[TW] OR “articular cartilage”[TW] OR chondral[TW]))) AND (sensitiv*[Title/Abstract] OR sensitivity and specificity[MeSH Terms] OR diagnos*[Title/Abstract] OR diagnosis[MeSH:noexp] OR diagnostic[MeSH:noexp] OR diagnosis, differential[MeSH:noexp] OR diagnosis[Subheading:noexp] OR questionnaires[Mesh] OR “disability evaluation”[mesh:noexp] OR questionnaire[tiab] OR questionnaires[tiab] OR instrument[tiab] OR instruments[tiab] OR scale[tiab] OR scales[tiab] OR measurement[tiab] OR measurements[tiab] OR index[tiab] OR indices[tiab] OR score[tiab] OR scores[tiab])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (physical therapy modalities [MH] OR recovery of function [MH] OR rehabilitation [MH] OR therapeutics [MH] OR “physical therapy” [TW] OR physiother* [TW] OR recovery [TW] OR restoration [TW] OR re-education [TW] OR early ambulation [MH] OR strengthening [TW] OR resistance training [MH] OR “resistance methods” [TW] OR exercise therapy [MH] OR biofeedback, psychology [MH] OR “neuromuscular electrical stimulation” [TW] OR pain management [MH] OR pain measurement [MH] OR mobilization* [TW] OR “continuous passive motion” [TW] OR manipulation, spinal [MH] OR ultrasonography [TW] OR ultrasound [TW] OR acupuncture [TW] OR laser* [TW] OR patient education as topic [MH] OR electrical stimulation [MH] OR electrical stimulation therapy [MH] OR Transcutaneous electric nerve stimulation [MH] OR taping [TW] OR bracing [TW] OR orthotic* [TW] OR weight-bearing [MH] OR Range of motion [MH] OR Treatment Outcome [MH] OR Exercise [MH] OR “physical therapy treatments” [TW] OR “training program” [TW])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (prognos* [tw] OR return to work [tw] OR return to work [MH] OR return to sport [tw])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (preval* [tw] OR incidenc* [tw] OR epidem* [tw])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (associat* [tw] OR risk* [tw] OR probabil* [tw] OR odds* [tw] OR relat* [tw] OR prevalen* [tw] OR predict* [tw] OR caus* [tw] OR etiol* [tw] OR interact* [tw])

Scopus

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (classif*))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (sensitiv*) OR TITLE-ABS-KEY (sensitivity and specificity) OR TITLE-ABS-KEY (diagnos*) OR TITLE-ABS-KEY (questionnaires) OR TITLE-ABS-KEY (“disability evaluation”) OR TITLE-ABS-KEY (questionnaire) OR TITLE-ABS-KEY (questionnaires) OR TITLE-ABS-KEY (instrument) OR TITLE-ABS-KEY (instruments) OR TITLE-ABS-KEY (scale) OR TITLE-ABS-KEY (scales) OR TITLE-ABS-KEY (measurement) OR TITLE-ABS-KEY (measurements) OR TITLE-ABS-KEY (index) OR TITLE-ABS-KEY (indices) OR TITLE-ABS-KEY (score) OR TITLE-ABS-KEY (scores))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (“physical therapy modalities”) OR TITLE-ABS-KEY (“recovery of function”) OR TITLE-ABS-KEY (rehabilitation) OR TITLE-ABS-KEY (therapeutics) OR TITLE-ABS-KEY (“physical therapy”) OR TITLE-ABS-KEY (physiother*) OR TITLE-ABS-KEY (recovery) OR TITLE-ABS-KEY (restoration) OR TITLE-ABS-KEY (re-education) OR TITLE-ABS-KEY (“early ambulation”) OR TITLE-ABS-KEY (strengthening) OR TITLE-ABS-KEY (“resistance training”) OR TITLE-ABS-KEY (“resistance methods”) OR TITLE-ABS-KEY (“exercise therapy”) OR TITLE-ABS-KEY (biofeedback) OR TITLE-ABS-KEY (“neuromuscular electrical stimulation”) OR TITLE-ABS-KEY (“pain management”) OR TITLE-ABS-KEY (“pain measurement”) OR TITLE-ABS-KEY (mobilization*) OR TITLE-ABS-KEY (“continuous passive motion”) OR TITLE-ABS-KEY (“spinal manipulation”) OR TITLE-ABS-KEY (ultrasonography) OR TITLE-ABS-KEY (ultrasound) OR TITLE-ABS-KEY (acupuncture) OR TITLE-ABS-KEY (laser*) OR TITLE-ABS-KEY (“patient education”) OR TITLE-ABS-KEY (“electrical stimulation”) OR TITLE-ABS-KEY (“electrical stimulation therapy”) OR TITLE-ABS-KEY (“Transcutaneous electric nerve stimulation”) OR TITLE-ABS-KEY (taping) OR TITLE-ABS-KEY (bracing) OR TITLE-ABS-KEY (orthotic*) OR TITLE-ABS-KEY (weight-bearing) OR TITLE-ABS-KEY (“Range of motion”) OR TITLE-ABS-KEY (“Treatment Outcome”) OR TITLE-ABS-KEY (Exercise) OR TITLE-ABS-KEY (“physical therapy treatments”) OR TITLE-ABS-KEY (“training program”))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-

APPENDIX A

ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY ("knee joint") AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY ("articular cartilage") OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (prognos*) OR TITLE-ABS-KEY (return to work) OR TITLE-ABS-KEY (return to sport))

((TITLE-ABS-KEY ("menisc*") AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY ("knee joint") AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY ("articular cartilage") OR TITLE-ABS-KEY (chondral)))) AND ((TITLE (prevalence) OR KEY (prevalence)) OR (TITLE (incidence) OR KEY (incidence)) OR (TITLE (epidemiology) OR KEY (epidemiology)))

((TITLE-ABS-KEY ("menisc*") AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY ("knee joint") AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY ("articular cartilage") OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (associat*) OR TITLE-ABS-KEY (risk*) OR TITLE-ABS-KEY (probabil*) OR TITLE-ABS-KEY (odds*) OR TITLE-ABS-KEY (relat*) OR TITLE-ABS-KEY (prevalen*) OR TITLE-ABS-KEY (predict*) OR TITLE-ABS-KEY (caus*) OR TITLE-ABS-KEY (etiol*) OR TITLE-ABS-KEY (interact*))

CINAHL

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (classif*))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (sensitiv*) OR TX (sensitivity and specificity) OR TX (diagnos*) OR TX (questionnaires) OR TX ("disability evaluation") OR TX (questionnaire) OR TX (questionnaires) OR TX (instrument) OR TX (instruments) OR TX (scale) OR TX (scales) OR TX (measurement) OR TX (measurements) OR TX (index) OR TX (indices) OR TX (score) OR TX (scores))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX ("physical therapy modalities") OR TX ("recovery of function") OR TX (rehabilitation) OR TX (therapeutics) OR TX ("physical therapy") OR TX (physiother*) OR TX (recovery) OR TX (restoration) OR TX (re-education) OR TX ("early ambulation") OR TX (strengthening) OR TX ("resistance training") OR TX ("resistance methods") OR TX ("exercise therapy") OR TX (biofeedback) OR TX ("neuromuscular electrical stimulation") OR TX ("pain management") OR TX ("pain measurement") OR TX (mobilization*) OR TX ("continuous passive motion") OR TX ("spinal manipulation") OR TX (ultrasonography) OR TX (ultrasound) OR TX (acupuncture) OR TX (laser*) OR TX ("patient education") OR TX ("electrical stimulation") OR TX ("electrical stimulation therapy") OR TX ("Transcutaneous electric nerve stimulation") OR TX (taping) OR TX (bracing) OR TX (orthotic*) OR TX (weight-bearing) OR TX ("Range of motion") OR TX ("Treatment Outcome") OR TX (Exercise) OR TX ("physical therapy treatments") OR TX ("training program"))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (prognos*) OR TX (return to work) OR TX (return to sport))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND ((TI (prevalence) OR SU (prevalence)) OR (TI (incidence) OR SU (incidence)) OR (TI (epidemiology) OR SU (epidemiology)))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (associat*) OR TX (risk*) OR TX (probabil*) OR TX (odds*) OR TX (relat*) OR TX (prevalen*) OR TX (predict*) OR TX (caus*) OR TX (etiol*) OR TX (interact*))

SPORTDiscus

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (classif*))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (sensitiv*) OR TX (sensitivity and specificity) OR TX (diagnos*) OR TX (questionnaires) OR TX ("disability evaluation") OR TX (questionnaire) OR TX (questionnaires) OR TX (instrument) OR TX (instruments) OR TX (scale) OR TX (scales) OR TX (measurement) OR TX (measurements) OR TX (index) OR TX (indices) OR TX (score) OR TX (scores))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX ("physical therapy modalities") OR TX ("recovery of function") OR TX (rehabilitation) OR TX (therapeutics) OR TX ("physical therapy") OR TX (physiother*) OR TX (recovery) OR TX (restoration) OR TX (re-education) OR TX ("early ambulation") OR TX (strengthening) OR TX ("resistance training") OR TX ("resistance methods") OR

APPENDIX A

TX ("exercise therapy") OR TX (biofeedback) OR TX ("neuromuscular electrical stimulation") OR TX ("pain management") OR TX ("pain measurement") OR TX (mobilization*) OR TX ("continuous passive motion") OR TX ("spinal manipulation") OR TX (ultrasonography) OR TX (ultrasound) OR TX (acupuncture) OR TX (laser*) OR TX ("patient education") OR TX ("electrical stimulation") OR TX ("electrical stimulation therapy") OR TX ("Transcutaneous electric nerve stimulation") OR TX (taping) OR TX (bracing) OR TX (orthotic*) OR TX (weight-bearing) OR TX ("Range of motion") OR TX ("Treatment Outcome") OR TX (Exercise) OR TX ("physical therapy treatments") OR TX ("training program"))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (prognos*) OR TX (return to work) OR TX (return to sport))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND ((TI (prevalence) OR SU (prevalence)) OR (TI (incidence) OR SU (incidence)) OR (TI (epidemiology) OR SU (epidemiology)))

((TX ("menisc*") AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX ("knee joint") AND (TX (menisc*) OR TX ("articular cartilage") OR TX (chondral)))) AND (TX (associat*) OR TX (risk*) OR TX (probabil*) OR TX (odds*) OR TX (relat*) OR TX (prevalen*) OR TX (predict*) OR TX (caus*) OR TX (etiol*) OR TX (interact*))

Cochrane Library

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AND (classif*)

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AND ((sensitiv*) OR (sensitivity and specificity) OR (diagnos*) OR (questionnaires) OR ("disability evaluation") OR (questionnaire) OR (questionnaires) OR (instrument) OR (instruments) OR (scale) OR (scales) OR (measurement) OR (measurements) OR (index) OR (indices) OR (score) OR (scores))

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AND (("physical therapy modalities") OR ("recovery of function") OR (rehabilitation) OR (therapeutics) OR ("physical therapy") OR (physiother*) OR (recovery) OR (restoration) OR (re-education) OR ("early ambulation") OR (strengthening) OR ("resistance training") OR ("resistance methods") OR ("exercise therapy") OR (biofeedback) OR ("neuromuscular electrical stimulation") OR ("pain management") OR ("pain measurement") OR (mobilization*) OR ("continuous passive motion") OR ("spinal manipulation") OR (ultrasonography) OR (ultrasound) OR (acupuncture) OR (laser*) OR ("patient education") OR ("electrical stimulation") OR ("electrical stimulation therapy") OR ("Transcutaneous electric nerve stimulation") OR (taping) OR (bracing) OR (orthotic*) OR (weight-bearing) OR ("Range of motion") OR ("Treatment Outcome") OR (Exercise) OR ("physical therapy treatments") OR ("training program"))

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AANND ((prognos*) OR (return to work) OR (return to sport))

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AND ((prevalence) OR (incidence) OR (epidemiology))

(("menisc*") AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR (("knee joint") AND ((menisc*) OR ("articular cartilage") OR (chondral)))) AND ((associat*) OR (risk*) OR (probabil*) OR (odds*) OR (relat*) OR (prevalen*) OR (predict*) OR (caus*) OR (etiol*) OR (interact*))

APPENDIX B

SEARCH RESULTS

Database/Source	Date Conducted	Results, n	Date Conducted	Results, n	Total, n
MEDLINE	November 2014	3773	December 2016	1900	5673
Scopus	November 2014	6692	December 2016	3879	10571
CINAHL	November 2014	2207	December 2016	672	2879
SPORTDiscus	November 2014	5573	December 2016	3044	8617
Cochrane Library	November 2014	244	December 2016	218	462
Cochrane reviews		6		3	9
Other reviews		15		3	18
Trials		221		204	425
Technology assessments		1		7	8
Economic evaluations		1		1	2
Total		18489		9713	28202
Total with duplicates removed		4990		2690	7680
Total with hand search				12	7692

APPENDIX C

CRITERIA FOR INCLUSION AND EXCLUSION OF STUDIES FOR REVIEW

Articles published in peer-reviewed journals that include studies of the following types: systematic reviews, meta-analyses, experimental and quasi-experimental, cohort, case series, and cross-sectional studies were included.

Exclusions: meeting abstracts, press releases, theses, nonsystematic review articles, case reports, and articles that cannot be retrieved in English.

Inclusion Criteria

Articles reporting on isolated and combined injuries for meniscus and articular cartilage injuries:

- The functional anatomy of the menisci and articular cartilage of the tibiofemoral joint

OR

- Tests and measures for diagnosis and/or differential diagnosis of meniscal and chondral lesions within the scope of physical therapist practice, including but not limited to "specific tests and measures"

OR

- Measurement properties of instruments and tests specific to measuring meniscal and chondral lesion–related outcomes (including but not limited to symptoms, functions, activity, and participation)

OR

- Measurement properties of instruments that are not specific to meniscal and chondral lesions BUT are specific to lower extremity outcomes

OR

- Measurement properties of instruments using data from a sample of patients with meniscal and chondral lesions

OR

- Primarily adolescents and adults (12 years old or older)
  - Studies reporting on persons younger than 12 years old IF the proportion in the sample is small (less than 5%) OR with separate data available for adults

AND

- Meniscal and chondral lesions, including the following topics:
  - Risk of meniscal and chondral lesions
  - Diagnostic characteristics of meniscal and chondral lesions, including but not limited to location, duration, and quality, and related impairments and functional limitations
  - Interventions within the scope of practice of physical therapists for meniscal and chondral lesions

All outcome studies were included.

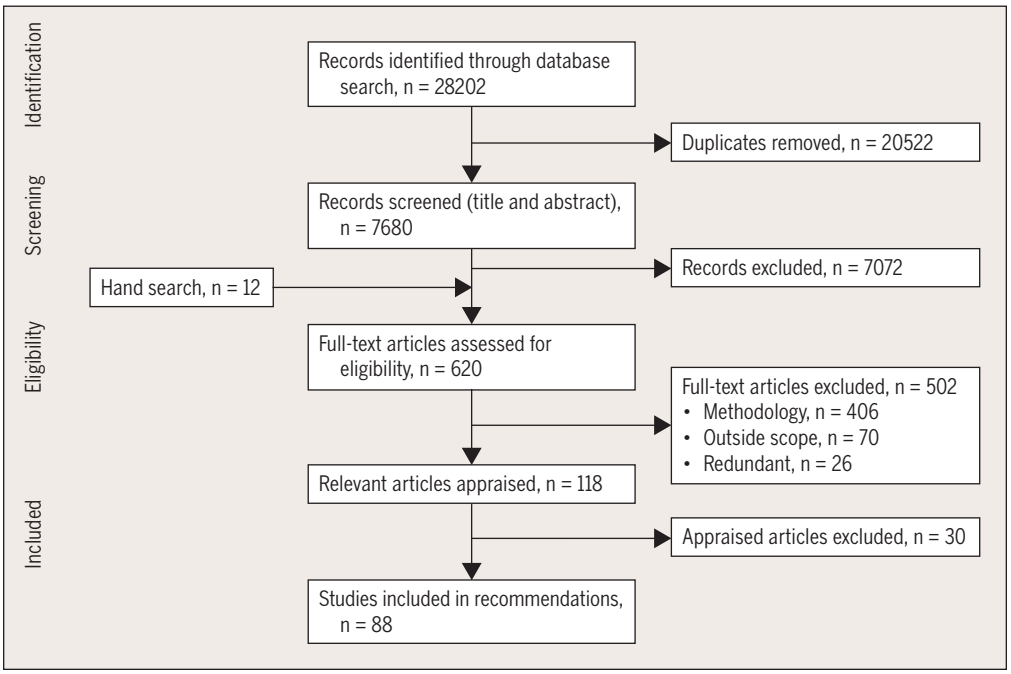
Exclusion Criteria

Articles reporting on:

- Osteochondritis dissecans lesions
- Primarily infants and children (younger than 12 years old)
- Ligament-related injuries of the tibiofemoral joint
- Patellofemoral pain, patellar tendinopathy/tendon pain, or iliotibial band
- Nonmusculoskeletal tibiofemoral pain
  - Diabetes
  - Ulcers
  - Primary peripheral nerve entrapment
- Topics outside the scope of physical therapist practice
  - Decisions to order radiologic tests
  - Pharmacological interventions
- Biomechanical studies

APPENDIX D

FLOW CHART OF ARTICLES



APPENDIX E

ARTICLES INCLUDED IN RECOMMENDATIONS BY TOPIC

Impairment/Function-Based Diagnosis

Incidence

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Yeh PC, Starkey C, Lombardo S, Vitti G, Kharrazi FD. Epidemiology of isolated meniscal injury and its effect on performance in athletes from the National Basketball Association. *Am J Sports Med*. 2012;40:589-594. https://doi.org/10.1177/0363546511428601

Clinical Course

Al-Dadah O, Shepstone L, Donell ST. Proprioception following partial meniscectomy in stable knees. *Knee Surg Sports Traumatol Arthrosc*. 2011;19:207-213. https://doi.org/10.1007/s00167-010-1237-7

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DIAGNOSIS/CLASSIFICATION: DIFFERENTIAL DIAGNOSIS

Examination

Outcome Measures

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Intervention

Progressive Knee Motion

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APPENDIX F

LEVELS OF EVIDENCE TABLE*

Level	Intervention/ Prevention	Pathoanatomic/Risk/Clinical Course/Prognosis/Differential Diagnosis	Diagnosis/Diagnostic Accuracy	Prevalence of Condition/Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT†	Systematic review of prospective cohort studies High-quality prospective cohort study‡	Systematic review of high-quality diagnostic studies High-quality diagnostic study§ with validation	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study‖	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study‡ Outcomes study or ecological study Lower-quality RCT¶	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Systematic review of exploratory diagnostic studies or consecutive cohort studies High-quality exploratory diagnostic studies Consecutive retrospective cohort	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Lower-quality exploratory diagnostic studies Nonconsecutive retrospective cohort	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case-control study	...	Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.

Adapted from Phillips et al[114] (http://www.cebm.net/index.aspx?o=1025). See also* **APPENDIX G.

†*High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.*

‡*High-quality cohort study includes greater than 80% follow-up.*

§*High-quality diagnostic study includes consistently applied reference standard and blinding.*

‖*High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses.*

¶*Weaker diagnostic criteria and reference standards, improper randomization, no blinding, and less than 80% follow-up may add bias and threats to validity.*

APPENDIX G

PROCEDURES FOR ASSIGNING LEVELS OF EVIDENCE

- Level of evidence is assigned based on the study design using the Levels of Evidence table (**APPENDIX F**), assuming high quality (eg, for intervention, randomized clinical trial starts at level I)
- Study quality is assessed using the critical appraisal tool, and the study is assigned 1 of 4 overall quality ratings based on the critical appraisal results
- Level of evidence assignment is adjusted based on the overall quality rating:
  - High quality (high confidence in the estimate/results): study remains at assigned level of evidence (eg, if the randomized clinical trial is rated high quality, its final assignment is level I). High quality should include:
    - Randomized clinical trial with greater than 80% follow-up, blinding, and appropriate randomization procedures
    - Cohort study includes greater than 80% follow-up
    - Diagnostic study includes consistently applied reference standard and blinding
    - Prevalence study is a cross-sectional study that uses a local and current random sample or censuses
  - Acceptable quality (the study does not meet requirements for high quality and weaknesses limit the confidence in the accuracy of the estimate): downgrade 1 level
    - Based on critical appraisal results
  - Low quality: the study has significant limitations that substantially limit confidence in the estimate: downgrade 2 levels
    - Based on critical appraisal results
  - Unacceptable quality: serious limitations—exclude from consideration in the guideline
    - Based on critical appraisal results

APPENDIX H

CRITICAL APPRAISAL SCORES

Clinical Course: Levels of Evidence Adapted From Phillips et al[114]

Study	SR of Prospective Cohort Studies*	SR of Retrospective Cohort Studies†	Lower-Quality Retrospective Cohort Study‡	Case Series	Expert Opinion
Frobell et al[52]	X				
Katz et al[78]	X				
Xu and Zhao[145]		X			
Hall et al[61]		X			
McLeod et al[97]		X			
Østerås et al[109]		X			
Al-Dadah et al[3]		X			
Busija et al[26]		X			
Fabricant et al[48]		X			
Zaffagnini et al[147]		X			
Kijowski et al[81]		X			
Hall et al[64]		X			
Hall et al[63]		X			
Hall et al[62]		X			
Thorlund et al[133]			X		
Thorlund et al[132]			X		
Stein et al[126]			X		
Scanzello et al[122]			X		
Kim et al[82]			X		
Goyal et al[58]	X				
Goyal et al[57]	X				
Campbell et al[27]		X			
Filardo et al[50]		X			
Harris et al[65]		X			
Chalmers et al[30]		X			
Howard et al[70]		X			
Mithoefer et al[99]		X			

Abbreviation: SR, systematic review.
**High-quality prospective cohort studies.*
†Includes lower-quality prospective cohort studies, high-quality retrospective cohort studies, consecutive cohort, and outcomes studies or ecological studies.
‡Includes high-quality cross-sectional studies and case-control studies.

Risk Factors: AMSTAR*

Study	1	2	3	4	5	6	7	8	9	10	11	Quality†
Snoeker et al[124]	Y	Y	Y	N	Y	Y	Y	CA	Y	CA	Y	H
Papalia et al[110]	Y	Y	Y	N	N	N	Y	Y	Y	CA	N	A
Petty and Lubowitz[113]	Y	N	N	Y	N	N	N	N	Y	N	N	L

Abbreviations: A, acceptable; AMSTAR, A Measurement Tool to Assess Systematic Reviews; CA, can't access; H, high; L, low; N, no; Y, yes.
**Yes/no. Items: 1, Was an a priori design provided? 2, Was there duplicate study selection and data extraction? 3, Was a comprehensive literature search performed? 4, Was the status of publication (ie, gray literature) used as an inclusion criterion? 5, Was a list of studies (included and excluded) provided? 6, Were the characteristics of the included studies provided? 7, Was the scientific quality of the included studies assessed and documented? 8, Was the scientific quality of the included studies used appropriately in formulating conclusions? 9, Were the methods used to combine the findings of studies appropriate? 10, Was the likelihood of publication bias assessed? 11, Was the conflict of interest included?*
†What is your overall assessment of the methodological quality of this review?

APPENDIX H

Risk Factors: SIGN Cross-sectional*

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Quality†
Chhadia et al[31]	Y	Y	DNA	DNA		DNA	Y	CS	CS	Y	CS	DNA	Y	Y	A

Abbreviation: A, acceptable; CS, can't say; DNA, did not access; SIGN, Scottish Intercollegiate Guidelines Network; Y, yes.
**Items: 1, The study addresses an appropriate and clearly focused question; 2, The 2 groups being studied are selected from source populations that are comparable in all respects other than the factor under investigation; 3, The study indicates how many of the people asked to take part did so, in each of the groups being studied; 4, The likelihood that some eligible subjects might have the outcome at the time of enrollment is assessed and taken into account in the analysis; 5, What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed? 6, Comparison is made between full participants and those lost to follow-up, by exposure status; 7, The outcomes are clearly defined; 8, The assessment of outcome is made blind to exposure status (if the study is retrospective, this may not be applicable); 9, Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome; 10, The method of assessment of exposure is reliable; 11, Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable; 12, Exposure level or prognostic factor is assessed more than once; 13, The main potential confounders are identified and taken into account in the design and analysis; 14, Have confidence intervals been provided?*
†How well was the study done to minimize the risk of bias or confounding?

Risk Factors: SIGN Cohort

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Quality†
Pestka et al[112]	Y	Y	N	N		N	Y	N	Y	Y	Y	Y	N	N	A
Salzmann et al[121]	Y	Y	Y	N		N	Y	DNA	N	Y	Y	N	N	N	A
Ebert et al[42]	Y	Y	N	Y		N	N	DNA	CS	Y	Y	N	N	Y	A
Jungmann et al[77]	Y	Y	N	N		N	Y	Y	Y	Y	Y	N	N	N	A
Hwang et al[71]	Y	Y	DNA	DNA		N	Y	DNA	CS	Y	Y	N	N	Y	A
Lyman et al[94]	Y	Y	N	DNA		DNA	Y	DNA	N	Y	Y	N	Y	Y	A
Brambilla et al[19]	Y	Y	N	N		N	Y	DNA	DNA	Y	Y	N	Y	Y	A
Jaiswal et al[73]	Y	Y	N	DNA		N	Y	N	N	Y	Y	Y	N	Y	A
Rosenberger et al[118]	Y	Y	N	N		N	Y	Y	Y	Y	Y	Y	N	Y	A
Wu et al[143]	Y	CS	Y	Y		CS	Y	NA	N	Y	Y	N	N	N	A

Abbreviation: A, acceptable; CS, can't say; DNA, did not access; N, no; NA, not applicable; SIGN, Scottish Intercollegiate Guidelines Network; Y, yes.
**Items: 1, The study addresses an appropriate and clearly focused question; 2, The 2 groups being studied are selected from source populations that are comparable in all respects other than the factor under investigation; 3, The study indicates how many of the people asked to take part did so, in each of the groups being studied; 4, The likelihood that some eligible subjects might have the outcome at the time of enrollment is assessed and taken into account in the analysis; 5, What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed? 6, Comparison is made between full participants and those lost to follow-up, by exposure status; 7, The outcomes are clearly defined; 8, The assessment of outcome is made blind to exposure status (if the study is retrospective, this may not be applicable); 9, Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessment of outcome; 10, The method of assessment of exposure is reliable; 11, Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable; 12, Exposure level or prognostic factor is assessed more than once; 13, The main potential confounders are identified and taken into account in the design and analysis; 14, Have confidence intervals been provided?*
†How well was the study done to minimize the risk of bias or confounding?

Risk Factors: SIGN Case-Control*

Study	1	2	3	4	5	6	7	8	9	10	11	Quality†
Englund et al[47]	Y	Y	Y		Y	Y	Y	Y	Y	Y	N	H
Kluczynski et al[84]	Y	Y	Y		N	Y	Y	CS	Y	N	Y	A

Abbreviation: A, acceptable; CS, can't say; H, high; N, no; SIGN, Scottish Intercollegiate Guidelines Network; Y, yes.
**Items: 1, The study addresses an appropriate and clearly focused question; 2, The cases and controls are taken from comparable populations; 3, The same exclusion criteria are used for both cases and controls; 4, What percentage of each group (cases and controls) participated in the study? 5, Comparison is made between participants and nonparticipants to establish their similarities or differences; 6, Cases are clearly defined and differentiated from controls; 7, It is clearly established that controls are noncases; 8, Measures will have been taken to prevent knowledge of primary exposure influencing case ascertainment; 9, Exposure status is measured in a standard, valid, and reliable way; 10, The main potential confounders are identified and taken into account in the design and analysis; 11, Confidence intervals are provided.*
†How well was the study done to minimize the risk of bias or confounding?

APPENDIX H

Risk Factors: Modified Case Series

Study	1	2	3	4	5	6	7	8	9	10	Quality†
Henry et al[68]	Y	Y	Y	CS	Y	Y	CS	Y	Y	Y	H
Crema et al[35]	Y	Y	Y	CS	Y	Y	Y	Y	Y	Y	H
Crema et al[34]	Y	Y	Y	CS	Y	Y	CS	Y	Y	Y	H
Ding et al[40]	N	Y	Y	CS	N	Y	CS	Y	Y	Y	A
Jacob and Oommen[72]	N	Y	Y	CS	N	Y	CS	Y	Y	CS	A

Abbreviation: A, acceptable; CS, can't say; H, high; N, no; Y, yes.
**Items: 1, Did the study address a clearly focused question/issue? 2, Is the research method (study design) appropriate for answering the research question? 3, Are both the setting and the subjects representative with regard to the population to which the findings will be referred? 4, Is the researcher's perspective clearly described and taken into account? 5, Are the methods for collecting data clearly described? 6, Are the methods for analyzing the data likely to be valid and reliable, and are quality control measures used? 7, Was the analysis repeated by more than 1 researcher to ensure reliability? 8, Are the results credible, and if so, are they relevant for practice? 9, Are the conclusions drawn justified by the results? 10, Are the findings of the study transferable to other settings?*
†How well was the study done to minimize the risk of bias or confounding?

Examination – Outcome Measures: Levels of Evidence Adapted From Phillips et al[114]

Study	SR of Prospective Cohort Studies*	SR of Lower-Quality Prospective Cohort Studies†	High-Quality Cross-sectional Study	Lower-Quality Cross-sectional Study	Expert Opinion	Quality‡
Engelhart et al[45]		X				A
Goodwin et al[56]		X				A
Garratt et al[54]		X				A
Salavati et al[120]			X			A
van de Graaf et al[136]			X			A
Almangoush et al[4]			X			A
Balain et al[13]			X			A
Smith et al[123]			X			A
Celik et al[29]			X			A
Vaquero et al[137]			X			A

Abbreviations: A, acceptable; SR, systematic review.
**High-quality prospective cohort study.*
†Lower-quality prospective cohort study.
‡What is your overall assessment of the methodological quality of this review? (high, acceptable, low, unacceptable).

Examination – Physical Impairment Measures: Levels of Evidence Adapted From Phillips et al[114]

Study	SR of Prospective Cohort Studies*	SR of Lower-Quality Prospective Cohort Studies†	High-Quality Cross-sectional Study	Lower-Quality Cross-sectional Study	Expert Opinion	Quality‡
Décary et al[37]		X				A
Blyth et al[18]		X				A
Haviv et al[66]			X			A
Snoeker et al[125]			X			A
Campbell et al[28]				X		L

Abbreviations: A, acceptable; L, low; SR, systematic review.
**High-quality prospective cohort study.*
†Lower-quality prospective cohort study.
‡What is your overall assessment of the methodological quality of this review? (high, acceptable, low, unacceptable).

APPENDIX H

Interventions: AMSTAR*

Study	1	2	3	4	5	6	7	8	9	10	11	Quality†
Fazalare et al[49]	CA	N	Y	N	N	Y	Y	Y	Y	N	N	A
Papalia et al[111]	CA	Y	Y	N	N	Y	Y	Y	CA	N	N	A
Dias et al[39]	CA	Y	Y	N	Y	Y	Y	Y	Y	N	N	A
Coppola and Collins[33]	CA	Y	Y	N	N	Y	Y	Y	CA	N	N	A
Reid et al[116]	CA	Y	Y	N	N	Y	Y	Y	Y	N	N	A

Abbreviations: A, acceptable; AMSTAR, A Measurement Tool to Assess Systematic Reviews; CA, can't access; N, no; Y, yes.
**Items: 1, The study addresses a clearly defined research question; 2, At least 2 people should select studies and extract data; 3, A comprehensive literature search is carried out; 4, The authors clearly state if or how they limited their review by publication type; 5, The included and excluded studies are listed; 6, The characteristics of the included studies are provided; 7, The scientific quality of the included studies is assessed and documented; 8, The scientific quality of the included studies is assessed appropriately; 9, Appropriate methods are used to combine the individual study findings; 10, The likelihood of publication bias is assessed; 11, Conflicts of interest are declared.*
†Quality rating: 8 or higher, high; 5, 6, or 7, acceptable; 4 or less, low.

Interventions: PEDro*

Study	1	2	3	4	5	6	7	8	9	10	11	Quality†
Kelln et al[80]	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	A
Edwards et al[43]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	H
Wondrasch et al[141]	Y	Y	Y	CA	N	N	Y	Y	Y	Y	Y	H
Akkaya et al[2]	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y	H
Lind et al[90]	Y	Y	Y	CA	N	N	N	N	N	Y	Y	A
Katz et al[78]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	A
Østerås[107]	Y	Y	Y	CA	N	Y	N	Y	Y	Y	Y	H
Østerås 2014[108]	Y	Y	N	CA	N	N	N	Y	N	Y	Y	A
Østerås 2014[109]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	H
Ebert et al[41]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	H
Oravitan and Avram[106]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	A
Koutras et al[86]	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	H
Kise et al[83]	Y	Y	Y	CA	N	N	Y	Y	Y	Y	Y	H
Hall et al[60]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	H

Abbreviations: A, acceptable; CA, can't access; H, high; N, no; PEDro, Physiotherapy Evidence Database; Y, yes.
**Items: 1, Eligibility criteria were specified; 2, Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received); 3, Allocation was concealed; 4, The groups were similar at baseline regarding the most important prognostic indicators; 5, There was blinding of all subjects; 6, There was blinding of all therapists who administered the therapy; 7, There was blinding of all assessors who measured at least 1 key outcome; 8, Measures of at least 1 key outcome were obtained from more than 85% of the subjects initially allocated to groups; 9, All subjects for whom outcome measures were available received the treatment or control condition as allocated, or, where this was not the case, data for at least 1 key outcome were analyzed by "intention to treat"; 10, The results of between-group statistical comparisons were reported for at least 1 key outcome; 11, The study provides both point measures and measures of variability for at least 1 key outcome.*
†Quality rating: 8 or higher, high; 5, 6, or 7, acceptable; 4 or less, low.

APPENDIX H

Interventions: Modified Case Series

Study	1	2	3	4	5	6	7	8	9	10	Quality†
Wondrasch et al[140]	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	H
Assche et al[11]	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	H
Neogi et al[102]	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	H
Lim et al[89]	Y	Y	CA	CA	N	CA	CA	Y	Y	Y	A
Elbaz et al[44]	N	Y	Y	Y	Y	CA	CA	Y	Y	Y	A
Della Villa et al[38]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	H

Abbreviation: A, acceptable; CA, can't access; H, high; N, no; Y, yes.
**Items: 1, Did the study address a clearly focused question/issue? 2, Is the research method (study design) appropriate for answering the research question? 3, Are both the setting and the subjects representative with regard to the population to which the findings will be referred? 4, Is the researcher's perspective clearly described and taken into account? 5, Are the methods for collecting data clearly described? 6, Are the methods for analyzing the data likely to be valid and reliable, and are quality control measures used? 7, Was the analysis repeated by more than 1 researcher to ensure reliability? 8, Are the results credible, and if so, are they relevant for practice? 9, Are the conclusions drawn justified by the results? 10, Are the findings of the study transferable to other settings?*
†How well was the study done to minimize the risk of bias or confounding?